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This document is the fourth in a series of six annotated bibliographies relevant to early childhood education. Its general subject is cognition, and it includes seven subdivisions: intelligence, higher mental processes, cognitive style, experimental studies of learning, concept development, perception and recognition, and motivation. Each of the 72 abstracts included has been classified by general and specific subject, by focus of study, and alphabetically by author. Focus of study categories are normative, environmental, measurement and techniques, intervention, pathology, physiology, animals, and general. The general subjects of other bibliographies in the series are language education, personality, physical, and social aspects of early childhood education. (MS)

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1968

This bibliography is Number 4 in a series of six. The general subject is Cognition, and it is divided into the following seven specific subjects.

1. Intelligence
2. Higher Mental Processes
3. Cognitive Style
4. Experimental Studies of Learning
5. Concept Development
6. Perception and Recognition
7. Motivation

The five other bibliographies in this series contain the following general subjects:

1. Physical
2. Language
3. Education
5. Social
6. Personality

Every abstract in this series has been coded at four levels; namely, general subject, specific subject, focus of study, and alphabetical by author. In all six bibliographies the focus of study is coded as follows:

1. Normative
2. Environmental
3. Measurement and Techniques
4. Intervention
5. Pathology
6. Physiology, etc.
7. Animals
8. General

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4.1
INTELLIGENCE

4.1.1 NORMATIVE

4.1.1.1 Honzik, M. A sex difference in the age of onset of the parent-child resemblance in intelligence. Journal of Educational Psychology, 1963, 54, 231-237.

Hypothesis: Is there a sex difference in the rate of increase in parent-child resemblance in mental ability?
Method: (a) A representative sample of 248 urban children born in Berkeley (January 1928 to June 1928) was divided into a control (C) group and a guidance one (G) and matched according to socioeconomic status. The parents and children in the G group were interviewed intensively, while those from the C group did not receive this treatment until the child was 17. Scores from the California Pre-School Scale (age 21 months) were then correlated to the parents' level of intelligence, as shown in level of education or status of father. (b) Scores from the subject's siblings were then correlated to the parents'. (c) Mental scores were then correlated to subject's children (called the Second Generation Study).
Results: NOTE: All these results are combined scores of the C and G groups. (a) The correlation of the daughter's IQ to the mother's level of schooling became significant at age 3 1/2 (r=.30, p<.01 level), while the correlation between son and mother became significant at the .01 level at age 5 (r=40). (b) At the p<.01 level, the correlation was significant between girl's IQ and father's level of education at age 3 and significant for boys at age 5. (c) Correlations for the experimenter's sibs were similar, though the number was very small and some of the experimenters did not have sibs. (d) When using the father's status (dependent on occupation, source of income, house type and dwelling area at the time of subject's birth), correlation for the daughter was significant at age 3 and for the son, significant at age 5. (e) In the second generation studies, the boy's IQ's correlated significantly (p<.01 level) with the parents' IQ's (taken at age 15) at age 5, while the girls' IQ's were correlated significantly at 19 months.
Conclusions: (1) A sex difference in the rate of mental growth is suggested (at ages 3 and 4, the difference is

significant at the $p < .05$ and $p < .07$ level respectively). (2) Higher cross sex correlations were obtained than same sex correlations. (3) Girls' mental abilities resemble their parents' earlier than that of boys. This may be due to either or both reasons: Girls cooperate more readily in the preschool testing situation than boys; and/or maturation of the central nervous system occurs earlier in the girls than boys. (4) For the second generation studies, the correlations are higher for girls at ages 3 and 4; but at age 5, the correlation is higher for boys.

4.1.2 ENVIRONMENTAL

4.1.2.1 Wiener, G., Rider, R. V., and Oppel, W. Some correlates of IQ changes in children. Child Development, 1963, 34, 61-67.

Hypothesis: Studies indicating that IQ changes in children are correlated with personality traits or parental behavior have been criticized by McNemar in that they are not controlled for statistical regression. Experimenters intend to show that IQ changes are not the result of statistical regression alone, but correlate with neurological status, socioeconomic background, and emotional stability.
Method: Three groups of 39 subjects each, matched for IQ (IQ range 80 to 109) at ages 3 to 5 were chosen from a longitudinal study at the John Hopkins Medical School, so that at ages 6 to 7, Group I (I) had an increase of 13 to 22 IQ points, Group II (II) had a decrease of 13 to 22 points, and Group III (III) had a decrease of 9 to 12 points. III was included to "replicate partially the initial found differences." Variables such as neurological status (as indicated by premature birth), social class (Warner's scale), and emotional stability (as observed) were then "associated" with IQ changes.
Results: (1) IQ and Neurological Status as indicated by premature birth: "Both groups of subjects with decreasing IQ's had a higher proportion of full term births as compared to I (increasing IQ scores)." No data given for X^2 between I versus II and III.
(2) IQ and Social Class: Rising IQ's were associated with upper social class status and declining IQ's with lower class status. No data were given for the significant differences between I versus II and III. On inspection (BR) no differences were found in middle class.
(3) IQ and Emotional Stability: "Initially children in I had a higher degree of emotional disturbances, but at ages 6 and 7, children in II and III began to show more emotional disturbances.

X^2 was significant between ages 3 to 5 and 6 to 7 for I ($p < .02$ level) and III ($p < .001$ level).

Conclusions: (1) "More subjects with increasing IQ scores, compared to those whose IQ scores declined, were of premature birth, came from a superior social class background, and had a more constant emotional adjustment."

(2) "IQ changes are not solely fortuitous phenomena associated with unreliable measures, but reflect processes regarding social class, emotional adjustment and possible minimal brain damage.

4.2
HIGHER MENTAL PROCESSES

4.2.1 NORMATIVE

4.2.1.1. Davidon, R.S., and Longo, N. Conceptual development reflected in age differences in association to names and pictures of objects. Journal of Genetic Psychology, 1960, 96, 85-92.

This study deals with the conceptual aspect of the associative process, and its stated purpose is to test simple suppositions about the development of differences in the rate and heterogeniety of conceptualizing, using the traditional method of free association. The hypotheses are: (1) associations will be faster for older subjects; (2) a longer time will be required for reaction to names of objects than to their pictures; (3) differences between the associations to names and pictures will change with age; (4) the number of different responses will be greater for pictured objects than for named ones; (5) the variety of responses will increase with age; (6) the number of repeated responses to the same object on successive trials will decrease with increasing age.

There were three groups of 20 subjects each, 10 boys and 10 girls per group. Group I: 10-year-old suburban fourth graders; Group II: 13-to 15-year-old eighth and ninth graders in junior high school; Group III: 18-to 20-year-old freshmen and sophomores in local college. The subjects were similar in IQ (brighter ones in the younger groups to compensate for college students), and in socioeconomic status background.

A magnetic tape recorder presented oral instructions and ready signals (tones) just before the presentation of a stimulus. Ten names and 10 pictures were presented to each subject in random orders for three cycles. After either the visual stimulus slide or the sounded name, a small green light appeared at the bottom edge of the screen, and remained lighted until the subjects responded into a microphone which was wired so as to turn off the light. This light proved to focus attention and stimulate rapid response. The instructions asked for a response of the first word which came into the subject's head, not a repeat of the sounded stimulus word, or the name of the picture. Half the subjects at each age group had the names of one set of objects and pictures to another set. An inquiry at the end of the session asked if the subject knew anything about the experiment beforehand, what subject thought the purpose of the experiment was, and if subject had had any difficulty in understanding or recognizing the stimuli.

The youngest subjects took significantly longer to associate, and longer reaction times, to names than to pictures ($p < .025$). The means of combined association times: Group I, 2.81 seconds; Group II, 1.90 seconds; Group III, 1.85 seconds. In relation to their respective association times to names, young children gave faster responses to pictures than did college students. Contrary to expectation, the heterogeniety of responses was as great for names as for pictures at all age levels. Some of the college students had thought that part of the purpose of the experiment was to remember their previous responses and so had made a conscious effort to recall, which might also have influenced their time. There seemed to be greater improvement in relating and verbally responding to names than to the corresponding pictures with age. Heterogeniety of response did not change with age and repetition did not decrease with age, but the above explanation of the college students might have something to do with this.

4.2.1.2 Graham, F.K., Ernhart, C.B., Craft, M., and Berman, P.W. Learning of relative and absolute size concepts in preschool children. Journal of Experimental Child Psychology, 1964, 1, 26-36.

From available literature, there are at least three ideas about the recognition of relative and absolute size concepts as a function of age. One implies that recognition of common relations involves a higher, more abstract process than of common elements; therefore, more immature organisms would be expected to learn the latter more easily than the former. Some writers suggest a primitive capability exists to respond to relative differences, and from stimulus-response mediating theory one would expect a differential age change according to the increasing ability to mediate relationships. Two experiments reported here investigated the ability of young children to respond to an absolute size and a relative size problem.

Subjects were white, of both sexes and mixed socioeconomic status, and within 2 months and 15 days of the age mean for the first and second studies, respectively. Ages were 2-0, 2-6, 3-0, 3-6, 4-0, and 4-6. Experiment I: 60 subjects, eight in each of the first three ages, and 12 in the last three age groups; Experiment II: 72 subjects, 12 in each group. The stimuli were size-graded

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white cards numbered 2, 3, 4, 5, 6, 7, and 8, and the positive stimuli had colorful pictures on the back; the others were blank. Subject got to keep the colorful picture cards which he had correctly chosen, for the duration of the experiment. In experiment I, 2-5 and 5-8 were the two card pairs used; in experiment II, pairs were 2-5, 3-5, 5-7, 5-8. In both experiments, subjects were randomly assigned to one of three positive reward conditions: (A) relative large; (B) relative small; and (C) absolute (card 5). Each subject received 31 trials.
Results: Experiment I, two-pair study, showed that the absolute choice was more difficult than the relative, but there was improvement with age. On the relative problems, maximum performance was approached by 3 years. Significant effects were age ($p < .01$), relative-absolute problem ($p < .01$), and relative large-relative small ($p < .05$). The four-pair choice, experiment II, appeared to be generally more difficult than the two-pair; age effect was linear ($p < .01$), relative-absolute effect ($p < .01$), and relative large-relative small effect ($p < .01$)--the small being easier than the large. There was little evidence that for this age and this size problem, the recognition or learning of a common relationship was more difficult or required more maturity than learning a common element.

The authors conclude that one must assume that relative size is a cue to which young children can respond. A multivariate chi-square design used on the two-pair revealed a significant differential over two trials of the effects of reward and nonreward for the relative cue. In stimulus-response theory, Spence's model does predict the possible age differential. A further inference is that older children show "conceptual behavior," "mediating responses," or "hypothesis-testing." Younger children are likely to repeat a response with or without reward, but the older child reflects a win-stay, lose-shift strategy. After 5 years of age, other tendencies may make the treatment of this data too complicated when other possibilities of responses may be effective.

4.2.1.3 Hansen, D.N., and Hansen, D.G. Information load in short-term memory with young children. Paper presented at The American Psychological Association Annual Meeting, 1965.

Some theories concerning the memory system hypothesize that it is composed of two parts: a short-term component, of limited capacity and permanency, and a long-term component, of almost unlimited capacity and relative permanency, The amount of information which a subject is required to process before recalling a particular item will partly determine the accuracy of the recall. This seems to provide a natural interpretation for latency data;

i. e., the processing time necessary before a response is produced. This study focuses upon whether younger children decrease in accurate recall as the information load increases more than older children do.

The 60 subjects, half boys, half girls, comprised three equal groups: Group 1, mean age 10.17 years, Group 2, mean age 5.61 years, and Group 3, mean age 4.47 years. Ten animal playing cards were used, presented singly at the rate of one per second, and laid face down in a row in front of subject. After the last card was shown and placed face down, a cue card, identical to one already shown, was presented, and subject was asked to turn over the original matching card. When incorrect, subject continued to turn over cards until he found the right one. Each subject received 10 trials on a five card set, and 20 trials on the full 10 card set. His first and second choice responses and the latency time from the presentation of the cue card to the touching of the first choice card were recorded.

Results: For all groups, the proportion of correct responses at a given position is a decreasing function of the number of items intervening between the presentation of the item and its test for recall. There was no evidence of a primacy effect, or tendency to choose the first card shown. There was a significant difference in response accuracy between the three age groups ($p < .001$). All subjects did significantly better on the five item tasks than on the 10 item ones ($p < .001$). There was a significant difference between the three age groups in response latencies ($p < .001$), and all subjects performed significantly faster on the five item tasks than on the 10 item ones.

The results are consistent with the theory in that superior performance of all subjects on the five item tasks may be accounted for by the higher probability of the item remaining in the short-term memory component, and the better performance by older subjects may indicate their larger short-term capacity (i. e., this assumes increase in capacity with age). Incorrect responses had significantly longer latency times which could indicate complete search time in both memory components. In summary, both age and amount of information input before recall had significant effects.

4.2.1.4 Jackson, S. Growth of logical thinking in normal and subnormal children. British Journal of Educational Psychology, 1965, 35, 255-258.

Purpose: To replicate some of Inhelder's and Piaget's experiments with English children of normal and subnormal intelligence and to see how far the growth of logical thinking might be revealed. Experiments used were: conservation of motion, equilibrium in the balance, falling bodies on an inclined plane, communicating vessels, law of floating bodies, oscillation of a pendulum (as described in Piaget's and Inhelder's Logical Thinking from Childhood to Adolescence).

Subjects: 48 children within IQ range 90-110, four boys and four girls in each age-group of 5, 7, 9, 11, 13, and 15 years; 40 children, drawn from three day schools, within IQ range 60-80, four boys and four girls in each age group of 7, 9, 11, 13, and 15. Most of the subjects "were from families of low socioeconomic status in the Manchester area" (explicit IQ and socioeconomic status measures were not given).

Method: Subjects were tested individually, completing all six experiments in one session, with a maximum of 1/2 hour per experiment. Raven's Progressive Matrices were given at the end of the session. A score of one was given for each substage completed of each test (three levels with two substages each, per experiment). The results were plotted on Guttman-type scalograms, and rank correlations calculated between these logical thinking scores and chronological age and Raven's Matrices scores.

Results: In three of the experiments, no normal subject reached the final stage of logical thinking described by Piaget, and which he had found in some of his 12- to 16-year-old subjects. Ninety-five percent of the subnormal subjects did not get beyond the first substage of concrete operations, level two, and none reached level three. Statistical tables are provided with the number of subjects in each age group reaching each substage, the number of subjects reaching each substage in each experiment, and the range (in number of substages) of individual subject's performance. The latter data support a previous finding that a subject's performance may be affected by the content of a task, as distinct from the required level of reasoning.

Lower levels of performance than reported by Piaget for this age range were found, and several responses he had classified as typical of certain stages either were not found or accompanied behavior at a different stage.

Rank correlations, obtained after combining the normal and subnormal groups, were + .608 between logical thinking and chronological age, and + .859 between logical thinking and Raven's Matrices scores.

Conclusions: (1) "Ability to think at a certain logical level in one situation does not necessarily imply the ability to think at that level in other situations." (2) Aside from the failure of older subjects to reach the final levels in three experiments, the normal sample generally confirmed Piaget's findings. This study also revealed that among children of similar mental age, there are wide variations in levels of logical thinking. (3) Subnormal subjects showed little score increase beyond nine years; subnormal 15-year-olds scored no higher than normal 8-year-olds, and there was some possibility of deterioration between 13 and 15 years in the subnormal group. (4) Further investigation was suggested for Piaget's definitions of stages of logical thinking in regard to children's test behavior and verbalization.

The author would add his findings to the larger body of similar data from which generalizations may eventually be made.

4.2.1.5 Offenbach, S.I. Studies of children's probability learning behavior: II. Effect of method and event frequency at two age levels. Child Development, 1965, 36, 951-962.

Introduction: In probability learning tasks (i.e., choosing which of two events will occur on a specific trial) two types of measures have been used: 1. "global"; i.e., the number of percentage of predictions of the more frequently occurring event; 2. "intra task"; i.e., response pattern of subject looking at scores in sequence and with reference to previous response. Studies with child subjects indicate that successive presentation of stimuli (Brackbill, Kappy & Starr, 1962 and Offenbach, 1964) is a more difficult task than simultaneous (Siegal & Andrews, 1962) (i.e., when both choices are before subject) as determined by successfulness of "matching behavior" (the prediction of one event about equaling the rate of occurrence of that event--Edwards, 1954).
Purpose: This study was designed to compare results on successive and simultaneous presentation tasks, and to extend the situation to cover 60 percent and 90 percent frequencies, an addition to the previous data for 75 percent frequencies in order to increase knowledge about developmental variables in probabilistic learning. The age groups were chosen because of predicted differential responses to probability (Inhelder & Piaget).
Method: (a) Subjects were 72 kindergarten students, mean age 5:6 years; and 72 4th grade students, mean age 9:7 years. All are students in the same suburban school district outside Pittsburgh, Pennsylvania. (b) The stimuli were 2X2-inch color slides. "The stimuli for the successive procedure were pictures of red and blue squares of color, 1 square slide." After a square of color was shown, the child was asked to predict which color square would appear next. Following his response, a color square would appear, thus informing the child whether his response was correct or not. The stimuli for the simultaneous procedure were pairs of red or blue squares of color. The child was shown a slide of two identical squares of color, side by side, and asked to predict which would come next; he then saw a slide with one square on one side of the slide and thus was able to see if he predicted correctly; that is, if the square of color appeared on the side on which he said it would. "Three 40-event probability sequences were constructed

using a table of random numbers." The event sequences consisted of 60 percent, 75 percent, and 90 percent occurrences of a specific color or a specific side occurring. "Each series was presented three times for a total of 160 trials. Red events and left events were the specified events in all cases." (c) Analyses of variance were performed on the number of correct responses in each block of 20 trials, thus dividing each 40-event sequence into halves. Analyses compared correct response frequency, grade, and trials. A Wilcoxon matched-pairs signed-ranks test was computed to compare the relative heights of the curves showing percentages of correct responses for each group of stimuli presentation. Three measures of intratask behavior were examined: "1.) a transitional probability--the percentage of correct and incorrect responses on trial based on what happened on trial n-1, 2.) response alternations (the number of times the child followed a prediction of one event with a prediction of the alternate event), 3.) the number of times the child made a correct response after the actual occurrence of an unusual event, usually incorrect." In the 75 percent and 90 percent trials there were no cases where two usually incorrect events followed each other and therefore the third method of analysis indicated whether the subjects had learned this.
Results: (a) The 90 percent group at both age levels made more correct responses than the other two groups, and the 75 percent groups made more correct responses than the 60 percent group--all are significant at the .01 level. (b) The age trials interaction is only significant (.05) in the 60 percent groups; the kindergarten children did not increase the number of correct responses above the change level, 50 percent, whereas the fourth grade students did. (c) The method of stimulus presentation effects and interactions (with age and event frequency) was not statistically significant. However, the simultaneous groups' result, as a whole, indicates that they engaged in behavior approximating "matching behavior" more frequently, significant at $p < .01$. This result pertains only to the difference between the two curves, curves showing the percentage of correct responses in each block of 20 trials in the 75 percent event. (d) Fewer alternations of responses occurred as the frequency of correct events increased, 60 percent to 75 percent to 90 percent, significant at $p < .01$. (e) "The Successive groups alternated more frequently than did the simultaneously groups," significant at $p < .05$; the kindergarten children alternated more frequently than the fourth graders, not significant. (f) The number of times an unusual event occurred to be followed by a prediction that a usual event (red or left side) would occur decreased over trials, but the frequency of this combination is significant ($p < .01$) among the 60 percent groups. The frequency of this combination of responses interacts significantly ($p < .01$) with age and trials in the 75 percent event. In the 90 percent event group, only the trials effect with

statistically significant (p<.01). In the 75 percent event, the curve plotting the frequency of this combination of responses increased with trials and increased faster with fourth grade students than it did with kindergarten subjects.
Discussion: (a) No significant difference was noticed between the two different methods of stimulus presentation, although the children in the successive groups did more closely approximate matching behavior and their responses of correct events (red and left side) were more frequent than in the successive group. This was only observed in the 75 percent event. In the 60 percent, the kindergarten children could not distinguish it from chance, 50 percent, and in the 90 percent event, the children always predicted a correct response. Thus, in order for the method of stimulus presentation to influence behavior, the subject must first recognize that the responses are not recognized at the 60 percent and 90 percent levels. (b) An analysis of intratask behavior indicates that the children making many alternation responses were not responding on the basis of the previous outcome but responding to each event in isolation, although theoretically one would assume that to alternate responses one must utilize his previous response. Children in the simultaneous groups and fourth graders responded more in terms of previous outcomes than did children in the successive groups or in kindergarten. (c) Kindergarten children responded less frequently to events in combinations and sequences, as did the older children who were trying to find some rule governing the occurrence of two events. (d) Kindergarten children have only a rudimentary understanding of probability, whereas the fourth graders do understand it better but not as well as adults do. While both groups can distinguish frequency differences, the older children's behavior "was more appropriate from a probabilistic point of view."

4.2.1.6 Ricciuti, H.N., and Johnson, L.J. Developmental changes in categorizing behavior from infancy to the early preschool years. Paper read at SRCD meeting, Minneapolis, March, 1965.

Much categorizing behavior, as studied in adults and children, involves free sorting where the subject determines the salient characteristics of the groups he forms. A problem with very young children is that their performance largely may be a function of incomplete, distorted or inaccurate understanding of verbal instructions regarding the specific task they are asked to perform. This study is a longitudinal followup of 22 children, previously studied when they were 12 to 24 months of age, in respect to the nature and frequency of "cognitively structured manipulations" (what sort of and how often nonrandom patterns of handling the experimental objects were manifested, reflecting some form of mental ordering procedure), and the influence of various stimuli contrasts. In the first study, the predominantly preverbal subjects were given four simple object grouping tasks and encouraged to handle these via general suggestions to "play with" or "fix" the objects. Two major forms of classificatory behavior appeared: Successive, serial manipulation of similar objects; and, less frequently, spatial grouping of similar objects. A followup was desired after language development was well in progress.

Specific purposes of the followup: (1) to examine changes in the nature and frequency of serial ordering and object grouping behavior in infancy and at age 3 1/2. Since language is presumably more important for the older subjects, they were given two tasks with the same "spontaneous play" instructions as the infants, and two tasks with specific emphasis upon sorting according to similarities; (2) to examine changes in the qualitative features of children's groupings; to see the extent of emergence of a previously observed characteristic, that preschoolers often sort into very configurational arrangements; (3) to look for the stability of individual differences among the children.

Subjects were 12 boys and 10 girls, mean age at original testing was 20 months, at time of retesting was 40 months. In each of the four different object grouping tasks, there were four simple objects of one kind, and four of another kind. On two tasks, size difference between the two kinds of objects was the salient cue; on one task, the cue was different in form only; and on the fourth, there were differences in color, shape and tactual properties. Procedure: The array of eight objects was placed before the subject, and he was allowed 2 to 2 1/2 minutes to play. The experimenter and one or two observers took a detailed record of all the subject's object manipulations from behind a screen. If the objects were not completely grouped at the end of the time, they were presented again on a tray with two recessed cups. Subject was only encouraged to play with the objects if this was necessary. In the followup, the first two tasks presented were accompanied with general instructions to play, and the last two tasks with specific sorting instructions. Behavior protocols were coded jointly by the examiner and the observer(s). Responses were coded independently for both order and structure (or grouping characteristics).
Results: The percentages used are of the children in each age group whose performance revealed the indicated behavior. Serial ordering--at 20 months the most common type is successive manipulation of four objects of one kind (20 percent); second successive manipulation was of objects in both groups (10 percent). At 40 months, successive manipulation of all eight objects in both groups was more than three times as frequent as at 20 months ($p < .003$). With specific sorting instructions the 34 percent increased to 50 percent. Serial ordering of four objects of one kind occurred

significantly less often at 40 months ($p < .02$). About 15 percent of the older children manipulated objects in a successive alternating sequence, never seen at 20 months. The frequency with which similar objects were spatially separated into groups at 20 months, the most common manifestation was gathering all or most of the objects in one group only or pairing of two similar objects. Each of these behaviors was seen in slightly more than 10 percent of the 20-month infants. At 40 months there was a sharp increase in complete grouping of both sets of objects, especially given specific instructions ($p < .01$). There was a slight decline at 40 months in the structuring of a single group and similar pairs. There was also a change in the types of response combinations involving both selective ordering and object grouping seen at the two age levels. At 40 months there were seen nonseparated configurational groups, and dissimilar objects grouped together or arranged symmetrically. At 20 months, about 40 percent of subjects displayed neither ordering or grouping behavior on the average task presentation; at 40 months, only 25 percent did this, given general instructions ($p < .005$); and only 12 percent, given specific instructions ($p < .001$). At 40 months, more than half of the object groups were arranged configurationally (none at 20 months). There was no significant relation between an individual's scores at 20 months and at 40 months. Conclusions: By early in the second year, children reveal primitive categorizing behavior in handling objects, which suggests a preverbal basis for this behavior. There is a marked increase in such behavior by 40 months, with the tendency to impose grouping upon all the objects presented, not just a subset; and this is increased when specific instructions to sort are given. The results were also in accordance with the description given by Inhelder and Piaget of the "graphic" or "figural" aspect in the development of classificatory behavior (2 to 4 1/2 years).

4.2.1.7 Weir, M. W. Developmental changes in problem-solving strategies. Psychological Review, 1964, 71(6), 473-490.

This is a developmental analysis of certain problem-solving behavior on a task similar to those employed by the Kendlers. The assumptions made are that differences in performance at different ages or different stages of the task reflect hypotheses and strategies on the part of the subjects. Strategies are inferred from performance, and the hardest group in which to confirm the findings are the youngest children, who perhaps are also undergoing the most rapid change. Information reported here is mainly based on group rather than on individual performance.

Subjects were 290 children, adolescents and adults, 3 to 20 years of age, from public and private schools and a college, and generally from the middle to upper-middle socioeconomic class. Subjects were tested individually on an apparatus involving a panel with three knobs which might produce a marble when pushed. The objective was to win as many marbles as possible. Prizes were used as reward for the younger children. In the total 80 trials for each subject, only one knob paid off, on a reinforcement percentage of either 33 percent of 66 percent. No solution yielded 100 percent reinforcement. Maximization was defined as obtaining the largest possible number of marbles; i.e., 100 percent choice of the payoff knob.

Results of this study, discussed over many pages, drawing in relevant references from other work, are reported here: (1) The terminal level of response, trials 61 to 80, showed maximization to be a function of age and of reinforcement percentage, significant in both the 33 percent condition ($p < .001$) and the 66 percent condition ($p < .05$). Variation across age groups is due to the quadratic component, significant at both percent levels, and appearing as a "U" shape function. The 3-, 5- and 18-year-olds showed similar levels of performance at the end of 80 trials, but different learning curves indicate that different processes were involved. (2) Group learning curves reveal that 3- and 5-year-olds rapidly rise to their highest level of response. Weir postulates that young children respond to the payoff knob on a simple reinforcement idea and are not discouraged by less than 100 percent reinforcement (this is similar to Kendlers' idea of single unit stimulus-response at this age). A definite and apparent strategy early in task performance seems to indicate fairly primitive problem-solving behavior. Other studies reveal adults seem to expect to be able to find a solution nearing 100 percent reinforcement or 100 percent predictability. Older subjects, usually expecting complex solutions, may thus be hindered by their expectation. The oldest of Weir's subjects, who terminally were performing at a high level, seemed to have arrived at a maximizing strategy through a very different process than the youngest subjects. (3) Response patterns are commonly a progressive search, left-middle-right and the reverse. Separate ANOVA's on the two reinforcement conditions disclosed a significant difference among age groups in this behavior, and the mean number of such search patterns for all the 33 percent groups combined was significantly higher than the mean number of such responses by subjects in the 66 percent condition ($p < .001$). The relationship between age and this response behavior in the 66 percent condition was an inverted "U" (curvilinear regression analysis, ($p < .001$), but for the 33 percent condition, the relation was linear, althoug the 3-year-olds differed significantly from the 5-, 7- and 9-year-olds. Children (about 7 to 10 years) seem to respond in a stereotyped manner using several search patterns as though they lacked more complex patterns (i.e., they either lacked the ability to hypothesize other patterns or cannot utilize all the information available to them). Data from other studies suggest that the U curve function of the relation between age and terminal level of performance for a two-choice task should have its lowest point at a younger age than the U curve for a three-choice task. (4) Reinforcement would be expected to have a different influence according to age, as the information provided effects the pattern response and strategy used. Through 9 years of age there was a tendency to repeat a response more often after a reinforcement than after a nonreinforcement; this tendency reversed after 11 years. This finding is in agreement with other experimental work and may reflect a more subtle strategy being employed by the older subjects. The average percentage response repetition following either a reinforcement or a nonreinforcement, by age group, showed a significant change of response repetition associated with age ($p < .01$) for the 33 percent condition and ($p < .001$) for the 66 percent conditions. Other studies support the findings here that 3- and 5-year-olds and adults, in both reinforcement conditions, had an overall tendency to repeatedly choose the payoff button, while the middle-aged children used more of a win-stay, lose-shift strategy. To assess the response repetition which subjects brought with them to the task, the proportion of subjects at each age who repeated their previous response after the first reinforcement or nonreinforcement (i.e., their response on the second trial) was calculated, and the pattern appeared to be very similar to the percentage response repetition by age in the 33 percent condition, indicating that the 33 percent reinforcement condition might not have been sufficient to produce much change in strategies as the strategies related to reinforcement/nonreinforcement.

4.2.1.8 Zeiler, M.D. Component and configurational learning in children. Journal of Experimental Psychology, 1964, 68, 292-296.

The purpose of this study is to see the relative importance of component and configurational learning by children when either is possible. In two and four situational discrimination problems, two separate discriminations are involved: in a two-situational problem, the stimulus pair is presented in only one of two possible spatial arrangements, and therefore, each discrimination could be learned on the basis of internally undifferentiated configuration (response to total configuration = response differentiation) or on the basis of a specifically rewarded component (= stimulus differentiation). In the four-situational problem one may approach a specific component in each pair or respond in the same way to a given pair.

Subjects were 48 children from New York City day care centers, 16 at each age level:

Group	girls	boys	age range	median
3 years	8	8	39-49 months	44 months
5 "	8	8	60-68 "	63 "
7 "	6	10	82-88 "	84.5 "

These were randomly assigned to one of two groups within each age level which were designated according to the type of test; e. g., component 3, configuration 3, etc. All subjects were trained on a two-situational problem and, immediately upon reaching criterion, were tested on a four-situational problem.

A red disc reward was concealed in the side of the correct block. The block stimuli were two black equilateral triangles, with sides of 3 3/4 inches and 7 1/4 inches, and two discs, green and red with diameters of 4 inches. Criterion in the training and testing was nine out of 10 correct responses, and a noncorrection procedure was used. Presentation of the stimulus pairs was completely counterbalanced; i. e.; each discrimination of triangles or discs was presented twice in every block of four trials. Subject was not informed of the change to the test situation which followed obtaining the criterion level in training. In the four-situational problem of the component groups, the same component remained positive, and for the configurational groups the same spatial position remained positive. A maximum of 60 trials was given in a test. The overall mean of trials to reach criterion was 19. 5.

Results:

Group	Mean	Median	Standard Deviation
Component-3	30. 00	28. 0	13. 98
Configuration-3	13. 38	12. 0	3. 81
Component-5	12. 50	10. 0	3. 81
Configuration-5	32. 63	28. 5	17. 38
Component-7	10. 63	9. 5	2. 87
Configuration-7	46. 50	60. 0	17. 52

Two issues may be considered: (1) the relative importance of component and configurational learning. When the number of trials to criterion for the two groups at each age level is compared, the type of four-situational problem learned more rapidly may be assumed to be most important to that age level. An ANOVA on the number of trials to criterion in the test gave an F = 12. 89 (df = 1, 42), $p < .001$, or significant difference for the type of test. Interaction between the type of problem and the age level was also significant, F (2, 42) = 18. 15, $p < .001$. Duncan's New Multiple Range Test was used for the significance of configurational learning being less difficult than component learning at the 3-year level ($p < .05$) and component learning being easier than configurational at both older levels ($p < .001$). (Nonparametric checks were done on these statistics because the variance was heterogenious and the distribution not normal: Kruskal-Wallis one-way ANOVA on the F values, and Mann-Whitney U Test on individual comparisons.) While all three age levels displayed almost equal immediate transfer on the component problem, the relative importance of component learning is directly associated with age. (2) The ease with which subjects shifted to a subordinate type of learning after solving problems on the basis of a dominant type may be seen by comparing the performance of poorer groups at each age level as an indication of the relative difficulty in shifting from the most important type of learning in the training situation to that type of learning required by the less readily learned test problem. Component-3 and Configuration-5 surpassed chance (75 percent) and neared perfect performance on the test, but Configuration-7 only rose to insignificantly better than chance in the test situation. The youngest subjects shifted most easily from a dominant to a subordinate type of learning.

Discussion: One hypothesis to explain these results is that with increasing age, there is greater difficulty in abandoning responses based upon previously relevant aspects. There seems to be differing degrees of isolation of the relevant aspects of the stimulus, or one might consider the Kendlers' theory about a single unit stimulus-response for young children versus a mediational model for processes in older children and adults. The author prefers to rest upon the suggested complexity of the relationship of ontogeny and learning, and concludes that since at 5 years, the processes underlying the nonreversal shift are more similar to the 3- than the 7-year-old, while what was learned in the training was more like that of the older subjects, there are at least two separate processes responsible for the differences shown by the 3- and 7-year-olds, and that these processes do not develop simultaneously.

4.2.2 ENVIRONMENTAL

4.2.2.1 Hess, R. D., and Shipman, V. Early blocks to children's learning. Children, 1965, 12, 189-194.

This study (one of a series) was undertaken with a view to broad questions concerning the nature and effect of cultural deprivation and its depressive influence on cognition, with special attention to the young child. Two stated assumptions are: (1) the structure of the social system and of the family shape communication and language; (2) language shapes thought and cognitive styles of problem-solving. Specifically, parallel to Bernstein's two forms of communication codes (restricted--stereotyped, limited, condensed, impersonal; and elaborate--situation--specific, individualized), two family types were postulated as characterized by these styles of verbal behavior and patterns of relationships therein evolved (i.e., families oriented (1) to control via status and role expectations; (2) towards persons). Assuming that children are taught what to attend to and how to interpret and respond, they would presumably develop significantly different verbal and cognitive facility.

Purpose: To discover how the teaching styles of mothers induce and shape learning styles and problem-solving strategy in their children, with the expectation of following the children through the first four school years. This is basically a preliminary analysis in terms of socioeconomic differences. Subjects were 160 Negro mothers and their 4-year-olds, drawn from four socioeconomic groups: (A) college educated, professional, middle class; (B) skilled blue collar, upper-lower; (C) semiskilled and unskilled, elementary educated, lower-lower; (D) father absent, AFDC. Mothers were taught three tasks which they, in turn, were to teach their own children; i.e., to sort toys by color and function; to sort blocks by two characteristics simultaneously; to work with child in copying five designs. Mother-child interaction was observed and at the end of each session the child's achievement was scored on: (1) ability to sort correctly and (2) ability to verbalize the sorting principle.

Results: There was a wide range of individual differences in linguistic and interaction styles of the mothers and a marked social class difference in the ability of children to learn from the mothers. Over 60 percent of the middle class children sorted correctly on all tasks (the other groups went as low as 33 percent) and 40 percent of the middle class group could verbalize the principle involved. Middle class mother-child teams performed much better on the design drawing than did any of the other three groups (mean scores of 14.6 versus 9.2, 8.3, 9.5). Excerpts from protocols exemplified vast differences in style and content of instructions to children, reflecting mother's ability to control her own and her child's performance. Mothers in the three lower socioeconomic groups were relatively persistent in the drawing task, and the child's cooperation was at least as good, if not better, than in the middle class group. There appeared to be little difference between groups in the affect expressed; but middle class mothers gave more praise, along with as much criticism, as did the other mothers.

Discussion-Conclusion: All mothers were asked how they would prepare their children to enter school for the first time, and their statements were grouped as imperative versus instructive. Children entering school with a status orientation are prepared for rote learning, passive acceptance of school authority and a quite limited range of alternatives. Lack of thought or reflection about actions in restricted speech styles nearly eliminates consideration of alternatives and consequences and this, the authors conclude, is where deprivation begins--an actual lack in meaning, and insufficient relation to a specific context. They found restricted speech in their lower class groups and relate this to eventually producing conditioned responses and immediate reactions rather than fostering problem-solving strategies as elaborated, individualized speech patterns and resulting interpersonal relationships would tend to do. The educational implication drawn from this study is the need for enrichment experiences to give stimulation in a pattern of sequential meaning and to relate ideas and events.

4.2.3. MEASUREMENT AND TECHNIQUES

4.2.3.1 Atkinson, R.C., Hansen, D.N., and Bernbach, H.A. Short term memory with young children. Psychonomic Science, 1964, 2, 255-256.

Recently the study of "short-term" memory has received attention as a focal point in verbal learning. This study concerns a technique to obtain relevant data from young children. Two groups of 20 subjects each, equally divided by sex, and of mean ages 4.16 and 5.09 years were used. A subset of eight out of a possible 11 animal playing cards comprised the stimuli for each of the 32 trials per subject. The child was shown each of the eight cards in turn, before it was placed face down in the row before him. The ninth card was identical to one of the previous eight, and the subject was to find the original card. Pictures were randomly assigned serial positions for each trial. First and second choices and latency time (from presentation of the cue card to touching the first choice card) were recorded.

Results: As expected, the proportion of correct responses at a given position was a function of the number of items intervening between the presentation of the item and its test for recall. There was no evidence of a primacy effect* such as older subjects displayed on similar tasks. The frequency of a particular position being a first choice showed that most errors, especially for the cards presented earliest in the trial, consisted of selecting the card immediately following the true position. Response latencies were faster for correct responses than for errors. Two possible explanations of the memory mechanism involved in this task were given: a direct association between a picture and a location on the table; counting backwards through all the items beginning with the one most recently presented. The authors reported that this technique sustained the children's attention and that during each session of approximately a half-hour, there were no signs of lagging or fatigue.

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* Primacy effect is the phenomenon of remembering the first items presented in a list with greater accuracy than items presented after the second or third item.

4.2.4 INTERVENTION

4.2.4.1 Robinson, H.B. An experimental examination of the size-weight illusion in young children. Child Development, 1964, 35, 91-107.

Charpentier's or the "size-weight" illusion is that phenomenon of the smaller of two objects of equal weight being perceived as the heavier of the two. In several studies dealing with this illusion, cognitive or perceptual set appears as an underlying and important variable since the illusion generally appears only when the subjects have first had an opportunity to judge the size of the objects, and the assumption is that there is the expectancy of larger objects being heavier. The experiments reported here investigate the developmental aspects of the illusion and the conclusions of others that the frequency of the illusion and its strength increase with age through early childhood. If Piaget's assumptions are correct, to test these conclusions, one needs only an empirical test to determine at what age the appropriate visual and kinesthetic schemata become coordinated. The increase with age of the number of children demonstrating the illusion might actually be a function of understanding the task.

Experiment 1--Purpose: To find the earliest age at which the illusion is elicited, by a method which assures that very young subjects understand the task, and to look for an age trend in the manifestation of the illusion. Subjects: 114 North Carolina children, 2 to 10 years of age, from a university community. Apparatus was the same for all experiments: a plywood clown face, "Happy," with open mouth, into which the subject "fed" the heavier weights. Sugar coated cereal was reinforcement. Stimuli were 15 pairs of brightly colored cylinders, each pair of unequal weights. Subjects were tested individually, told that Happy was hungry, and that he wanted to eat the heavier object of each pair as the pair was presented to the subject. Cereal, a flashing light and verbal reward followed correct responses. In the training trials, there was a 90-gram difference between the pair of same sized objects. There were 20 trials per session and three sessions per week, except for the older children who quickly demonstrated the concept of heavy, and who completed training and testing in one day. Mastery criterion was 19 out of 20 correct during two consecutive sessions. This insured the set for "heavier" and not "bigger." In the session following the training trials, five illusion trials were interspersed with 15 trials as above; in the illusion trials, objects which differed in size but were equal in weight were presented. Subjects were told, "That's fine," and given cereal, regardless of their response on these trials. Results:

Age groups	Number	Mean number training trials	% Illusion trials on which all subjects chose smaller obje
2.0-2.6 years	15	134	91%
2.6-3.0	15	93	87
3.0-3.6	13	60	92
3.6-4.0	14	49	91
4.0-4.6	15	45	95
5.0-6.0	14	41	91
6.0-8.0	15	43	93
8.0-10.0	13	40	89

Had subjects not experienced the illusion, the smaller object should have been chosen only about 50 percent of the time. There was no relation or trend of age with the manifestation of the illusion. The technique proved to be successful even with very young children.

Experiment 2--Purpose: To discover if there is an age trend with the stength of the illusion. The same subjects were used. In 27 trials following the testing session (Experiment 1), both size and weight of the pair of cylinders were varied, simultaneously, the larger object always being the heavier. The weight difference varied between 10 and 90 grams. The question was how much heavier the larger object had to be before it was perceived as heavier. Results showed an inverse relation of magnitude of the illusion manifested to age; the younger the child, the greater the illusion effect.

Experiment 3--Purpose: To discover if the illusion is related to weight discrimination ability. Experiment 2 suggested that the relation of age and magnitude might be a function of the fineness of discrimination ability of the child. Fifteen subjects, 2.0 to 3.0 years, were trained to discriminate pairs of cylinders which differed by only 30 grams; another 15 subjects, same ages, were trained to discriminate pairs differing by 60 grams. The same procedure as in Experiment 1 was used except that the training stimuli differed by only 30 or 60 grams. For comparison, the 30 subjects from Experiment 1 trained on a 90-gram difference had a mean number of 112 training trials; those trained on a 60-gram difference had a mean number of 130 trials, and those trained on a 30-gram difference had a mean of 200 trials. Thus the magnitude of the illusion is a function of training in weight discrimination.

General conclusions from these three experiments are that when both objects of a pair are of equal weight, the illusion is not a function of age for children between 2 and 10 years. The intensity of the illusion decreases with age, and appears to be a function of the ability to discriminate finely between weights. These conclusions are contrary to specific statements made by Piaget and the implications drawn by other investigators, most of whom assumed that young children would respond consistently to the verbal directions of "heavier" without any training. The author feels his findings are in line with the general theoretical position of Piaget regarding the development and integration of schemata.

4.2.4.2 Rossi, L. The development of classificatory behavior. Child Development, 1964, 35, 137-142.

This study investigates two hypotheses about the processes and possible levels of development of a categorical basis for classificatory behavior. An instrument of "associative recall clustering" of words, similar to Bousfield's, was used because it is quantitative, easily administered and objectively scored. Hypothesis 1: Because of the rapid increase in the use of verbal mediators between 6 and 8 years of age, one would expect a significant deviation from the linearity in the relationship of chronological age and associative recall clustering. Hypothesis 2: Since verbal mediation is involved in such grouping behavior, the presence of verbal mediators in the stimulus list should facilitate the overall amount of clustering in recall. There were 20 subjects at each chronological age level of 5, 8 and 11 years, with mean group IQ's (Peabody Picture Vocabulary Tests, Form B) between 95.3 and 95.9, chosen from a nursery school and public elementary school. Two stimulus lists each contained 20 words from four categories (food, animals, clothing, parts of the body), which were equated for mean log frequency of occurrence in juvenile literature of the Thorndike-Lorge word lists. List 2 included the words "animal," etc., in place of one of the words subsumed thereunder in List 1. Five different randomizations of each list were used for five trials with each subject. Half of the subjects at each chronological age received List 1, which they repeated word for word after the experimenter and then recalled as many of the words as possible. Each random order of the list constituted a trial. The measure of clustering used was DRc (corrected density ratio; i.e., the ratio of the number of stimulus list words clustered to the total number of words recalled from the list). The mean for the five trials for each subject was put into a 2X3 factorial, chronological age by use of mediational words. A trend analysis for significant linear and quadratic components of the main effect of chronological age showed only the linear relations as significant ($p. < .01$), and the interaction as insignificant. Both hypotheses were rejected, although subjects having verbal mediators showed much improvement in DRc between chronological age 5 and 8, and no improvement between 8 and 11. A more detailed analysis of the same data, including more subjects, and differentiating these by mental age, showed that verbal mediators facilitated clustering on trial 1 for mental age of 4.6 but not for mental ages of 7.3 or 10.0. This suggests that stimulus material should be carefully selected at an appropriate level of difficulty for the subjects involved. The ability to establish the existence of discriminable developmental levels in classificatory behavior may well be a function of the difficulty of the material or the interaction of materials and subjects rather than inherent stages in the developmental sequence.

4.2.4.3 Zigler, E., and DeLabry, J. Concept-switching in middle-class, lower-class, and retarded children. Journal of Abnormal Social Psychology, 1962, 65, 267-73.

Impetus for this experiment came from several postulations of a greater rigidity in mental retardates than in normals of the same mental age and, specifically, from the experiment of concept-switching by Kounin (1941). The main hypothesis of this study is that if equally effective reinforcers were provided to both normals and retardates of the same mental age, in a concept-switching task, no differential ability would appear. This assumes that for every child there is a reinforcement hierarchy, with the values of specific reinforcers determined by "the developmental level of the child, the frequency with which the reinforcers have been paired with other reinforcers, and the degree to which the child has been deprived of these reinforcers." Other studies have found differences in reinforcement effectiveness (tangible versus intangible) according to social class and that institutionalized, familial retardates largely come from the lower class. The specific predictions of this study: (1) retarded and lower class children perform more effectively on concept-switching given tangible reinforcement; middle class subjects, given intangible reward; (2) in the intangible reward situation, the middle class child will perform more effectively than either lower class or retarded children; (3) no difference will exist among the three groups in their ability to switch concepts when each group receives its optimal reinforcer. Subjects were three groups of 22 children each, matched for mental age (mean mental age = 6.9 years). Social class was determined by rating the occupations of parents according to the Warner's Index of Social Characteristics. Mean chronological age of retardates was 13.6; of normals, 6.3 years. Retarded subjects were institutionalized in a training school.

Two preexperimental tasks provided experience with the two principles of sorting to be used--color and form: Task I--25 colored cards were to be sorted according to the five colors; Task II--25 white cards, each printed with a shape, were to be sorted according to the five shapes. In Task III (the test for switching) the 25 cards were colored as in Task I, each of one color having one of the five different forms. The subject was asked to put these into groups, and when correct in this by either color or form, the subject was then asked to put the cards together some other way. Half of each group received (T) tangible reward (tokens at each of the four steps which could be used for a prize);the other half of the subjects heard no mention of reward but were told "right" after correct performance on Tasks I and II (I--intangible). A correct re-sort in Task III, or seven unsuccessful tries terminated the game. Each subject received a toy after all subjects were run.
Results: The experimenter recorded each subject's choice of color or form grouping and the number of trials necessary for correct re-sorting in Task III. A two-way ANOVA (type subject x reinforcement condition) on the mean number of trials for correct re-sorting gave significant F values associated with the type subject, reinforcement condition, and interaction ($p < .05$). The nature of the interaction supported the first prediction. Comparison of the three intangible groups gave an F value ($p < .01$) which supported the

second prediction. Also, the middle class, intangible group switched concepts more readily than did the retarded, intangible subjects ($p < .01$) or the lower class, intangible subjects ($p < .05$). There was no significant difference between the retarded, tangible subjects, lower class, tangible and either middle class group; thus the third prediction was supported.

4.2.5 PATHOLOGY

4.2.5.1 Caputo, D. V., Edmonston, W. E., Jr., L'Abate, L., and Rondberg, B. Type of brain damage and intellectual functioning in children. Journal of Consulting Psychology, 1963, 27, 184.

This is an attempt at more consistent assessment of intellectual functioning of children with minimum brain dysfunction and diffuse brain damage. Children with seizures have shown less impairment than children with nonseizure brain damage. It tested two hypotheses: (1) brain damage lowers intellectual functioning in comparison with emotional disturbance in children with non-seizure brain damage; (2) there are differences in particular areas of intellectual functioning between two specified types of brain damage and controls. This is an extended report from D. V. Caputo, Department of Psychiatry and Neurology, Washington University School of Medicine, 4940 Audubon Avenue, St. Louis, Missouri.

4.2.8 GENERAL

4.2.8.1 Gagne, R.M. The acquisition of knowledge. Psychological Review, 1962, 69:4, 355-365.

In this paper Gagne sets forth a theory of knowledge acquisition. He defines knowledge as "that inferred capability which makes possible the successful performance of a class of tasks that could not be performed before the learning was undertaken." This has also been called "productive learning"; it is what is acquired by means of responding correctly to a learning program. In a study of programmed learning by Gagne and Brown, 1961, the observations made led to the following formulation. In productive learning, there are two major categories of variables: (1) knowledge; i.e., the capabilities the individual possesses at any given stage in the learning; and (2) instructions; i.e., the content of the communications presented in for frames of a learning program. By analyzing the knowledge category, beginning with the final task and working backwards, Gagne identifies several separate entities of subordinate knowledge, essential to the performance of the final task, arranged in hierarchical fashion. (His example in this paper of the final task is finding formulas for the sum of terms in a number series.)

Gagne describes this process of the acquisition of knowledge as the action of these two classes of variables, as follows: "A human learner begins the acquisition of the capability of performing a particular class of tasks with an independent array of relevant learning sets, previously acquired. He then acquires new learning sets at progressively higher levels of the knowledge hierarchy until the final class of tasks is achieved. Attaining each new learning set depends upon a process of positive transfer, which is dependent upon a) the recall of relevant subordinate learning sets, and upon b) the effects of instructions." Also involved is a scaling notion: that lower-level sets are essential to the achievement of higher-level tasks. Gagne suggests beginning with extremely simple levels of tasks, such as discriminations, investigating transfer of training to tasks of greater and greater degrees of complexity or abstractness, thus determining the dimensions which make transfer possible. He suggests that the approach used in the experiment reported here, by proceeding backwards by analysis of an already existing task, can be used as a way of understanding the learning of school subjects. But such investigations of productive learning must also deal with "individual difference" variables; in other words, one must "measure and map out for each individual the learning sets relevant to the experimental task."

4.2.8.2 Inhelder, B., and Matalon, B. The study of problem solving and thinking. In H. Mussen (Ed.), Handbook of research methods in child development. New York: Wiley, 1960. Pp. 421-461.

Purpose and Background: The authors review the methods used to study problem-solving in children. The methods are divided into types according to the modality through which they study the problem-solver. There are three groups: sensory-motor methods, thinking proper, and concept development. Only the first two methods are abstracted, since concept development--the authors' main interest--is a review of Piaget. Problem-solving is defined as the situation in which a solution occurs through insight or logic, whereas learning is a situation in which the correct answer comes gradually with successive trials.
Sensory-Motor Processes: 1. Learning versus insight--distinguishing between learning and insight during an experiment is difficult and often impossible to do, making it necessary to withold judgment until the subject has finished his trials and his behavior can be studied. Because of the difficulty in communicating with animal and child subjects, it is frequently necessary to conduct the study as a learning experiment in which the subject grasps the problem through the results of his earliest trials. By observing his overall behavior, one is able to isolate problem-solving behavior. Many of Kohler's original experiments utilize this method and ask the subject to

construct "a detour or an intermediary"--a tool. Alpert (1928) observed preschool subjects asked to reach a reward suspended from the ceiling and just beyond their reach, but accessible with the use of some visible wood blocks. Richardson (1932) had infants select the correct string from a series of strings to release visible toys beyond reach. Richardson (1934) and Moriya (1937) studied subjects required to operate a lever in a direction contrary to how they usually use it; i. e., turning a door knob counterclockwise instead of clockwise. A correct response gave subject access to a visible reward. Studies by Lewin (1936), McGraw (1935), and Fajars (1933) have required subject to move away from his goal in order to reach it eventually. Kendler and Kendler (1956) in their experiments of "inferential behavior" have subject use a logical intermediary rather than a physical one. Rey (1935) studies practical intelligence in children 3 to 7 years old by having them use a tool and a detour to complete the task successfully. Rey's apparatus is a box with an opening on one side and a reward on a revolving cube in the center of the box. Subject must get the reward off the cube and out of the box using two sticks. Bussman (1946) studies transfer problems using apparatuses similar to Rey's. During pretraining the subject must combine elements provided by the experimenter to solve the problem and subject is given hints on how to do this. During the test trials, the subject must combine *more* elements than were needed during pretraining to solve the problem. All these studies minimize the role of language and analyze the process by which the subject acquires a solution. The reward helps the child subject maintain interest and is not "releasing" behavior as food does to animals.

Temporal Relations: Problems drawing on temporal relations require subject to remember his previous responses and to use this information when making later responses. Several apparatuses are used in such experiments. One is the temporal maze which "consists of a chamber divided into two parts, each closed by a door" that the experimenter controls. Usually, the left-hand door is open for two trials, the other closed for 2 trials and so on. Hunter (1913) used this device first and it has continued to be widely used with animal subjects. Gellermann (1913) used the temporal maze with humans, adults and children. His results emphasize the differences in experimental procedure that are related to differences in motivation between animal and human subjects; the former are strongly motivated by hunger or fear and the latter are stimulated by the experimenter's request to do something. Because the maze is cumbersome, Gellermann (1931) with monkeys and Hunter and Bartlett (1948) with children constructed a new device. They used two boxes which are placed in front of the subject. The experimenter stands behind the boxes and hidden from the subject. The subject is told a reward is in one box and must open a box to find the reward. After each trial the reward may be moved, but

the usual procedure is to leave the reward in each box for two trials and then move it. Another way of studying temporal relations is by delayed responses; that is, the correct choice is indicated to show the subject by a light or noise signal seconds before the trial occurs. Hunter (1913) had the subject choose one of three boxes for a reward, with the correct choice always lighting up a set time before the subject could respond. Miller (1934) hid a toy in one box while the subject was watching but removed it without the subject's knowledge and before the subject chose. He then studied the cues used by the subject to make choices and this was really involved with discrimination learning.
Conclusions: A variety of methods is necessary to study problem-solving behavior in all its forms.

4.2.8.3 Johnson, D. M. A modern account of problem solving. *Psychological Bulletin*, 1944, 41, 201-279.

Purpose: To identify the essential elements of the problem-solving process and to review the literature relevant to these elements. The author distinguishes between materials and processes of thought, the static and the dynamic. Materials of thought are perceptions, affects, concepts and combinations of these towards which thought is directed. The activities of thought are many but a basic pattern does emerge for the process of problem-solving. Basic paradigm of the problem-solving process: 1. "Orienting to the problem" focusing on the materials of thought and keeping them available. 2. "Producing relevant material, an elaborative function"; using numerous mental processes to select and manipulate information to produce possible solutions. 3. "Judging": the evaluative phase when one or more of the alternatives is selected as a possible solution. Literature relevant to this stage is not reviewed in this article.
Findings: (1) Orientation to the problem-orientation facilitates responses to some stimuli and inhibits responses to others, thus helping the problem-solver to focus on the stimuli he considers relevant. When the solution is to be communicated to other people, the problem enlarges to include "a persuasive phrasing of the solution" or rationalization which orients the thinker toward verbalization, logical forms, and the likes and dislikes of his audience (Mead, G. H., 1934; Piaget, 1928; Rignano, E., 1927). The initial orientation occurs through an interference in activity but soon changes focus and direction. Man can orient to and remember long enough to report on only a finite amount of material called "span of apprehension" or "immediate memory span." Factors affecting orientation ability are throught also to affect processes intrinsic to the elaborative and judging stages of problem-solving. Orientation is disturbed or lost when people voluntarily give it up to concentrate on less difficult material or when a problem contains two similar types of relevant material. One series of

material has a distracting "effect on attention to the other series of relevant material and interferes and confuses one's thinking. These effects do not occur if one of two similar series of material is irrelevant to the problem (Hovey, H. B., 1928). Confusion due to similiarity in information may be reduced by writing down the material in an orderly manner, by vocalizing it or by mentally assembling the material in a pattern meaningful to the thinker. Orientation capacity is thought to be related to the condition of the cerebral tissue although research in this area is incomplete; changes in orientation affect muscle tension, Alpha rhythm, bodily movements and winking rate. Individual differences in orientation occur mainly in the size of the immediate memory span." Developmental data collected by D. Wechsler (1941) reveals that span increases until age 20 or 24 and then decreases. Studies of span in children 2 to 6 years old reveal that the temporal dimension of span, called span of attention or interest, is as important as the breadth of span (Gutteridge, M. V., 1935). (2) Production of relevant material--During the second stage of problem-solving, materials relevant to the topic to which the thinker is oriented are produced from the present situation, memory, preception and communication with others. Generalizations are particularly important at this time because they can contain much information. The collection of relevant data at this time assumes the form of a search of which there are many types. Spearman (1931) has studied the search for relations and correlates; Maier, N. R. F. (1931, 1940) has studied the synthetic search "a combination of isolated experiences." Gestalt psychologists concentrate on the analytic search which results in a reorganization of the material. Regardless of the type of search, each creates a "search model" that is developed from the requirements of the solution as they are understood by the thinker. The model changes as the search progresses and more is known about the problem and its possible solutions. When the problem is too complex to be fit into an overall "search model" or earlier solutions fall, another "plan of action" is used: breakdown the problem into smaller problems and approach each in turn. Numerous other plans exist and others are invented ad hoc. In a difficult situation, much thought will occur that is seemingly random but actually controlled by deeper processes and very helpful in problem solving. Creative thought is another type of search model: a combination of freedom and control. Studies reveal that the sequences of thoughts during the search for a solution are irregular and very greatly depending upon the type of material, the problem, and the level of difficulty. The availability of material during the search is controlled by the affective state of the thinker and the affective connotations of particular material, by the preserve of a response set, by the thinker's general mental flexibility and self-confidence. Studies of individual differences in search models reveal that cultural biases are omnipresent and that differences also exist due to sex, educational background, intelligence, personal

preference, imagination and age (Amen, E. W., 1941; Andrews, E. G., 1930; Jersild, A., 1933). (3) Problem-solving ability--Little is known about this ability as a measure of general intelligence or a manifestation of a particular ability. Though it is utilized on countless tests, it is not yet clear what these tests measure (Billings, M. L., 1934). Studies relating individual differences in thinking and other personality variables are badly needed.
Conclusion: By separating the materials and processes of thought and then discussing problem-solving in a general way, a useful plan for ordering the literature emerges.

4.2.8.4 Yost, P.A., Siegel, A.E., and Andrews, J.M. Nonverbal probability judgments by young children. Child Development, 1962, 33, 769-780.

This study compares Piaget's technique for assessing the probability concept in young children with a decision-making technique. A summary of one of Piaget's papers based on 14 subjects, 5 to 12 years, says that children up to 7 years are not consistent in their predictions of what color marble could be drawn according to quantitative proportions; i.e., that they do not have an idea of probability; 8- to 10-year-olds do not get the implications of not replacing items in the assortment; children older than 10 years do understand the change in probability in the situation after each new drawing of an item from an assortment. The authors' criticism of Piaget's paper is that he relied on verbal understanding, color preference was confounded with color expectation, the position of an identical set of items to those being drawn is not random and may be confusing, there was no incentive or reward, and there was no provision for statistical analysis of the data.

4.3
COGNITIVE STYLE

4.3.1 NORMATIVE

4.3.1.1 Santostefano, S., and Palley, E. Development of cognitive controls in children. Child Development, 1964, 35, 939-949.

Hypothesis: Traditionally investigators have placed emphasis on the nature of the stimuli giving rise to perceptual experience. Recently, attention has shifted to the individual's cognitive structures, which determine the amount and organization of information which becomes available to the perceiver and the experimenter's attempt to "explore whether test methods could be devised to yield measures in the cognitive functioning of children, of two controls...and to explore whether these cognitive principles follow a developmental scheme." These two controls are seen as (a) focusing-scanning, which relates to the manner in which attention and concentration is deployed or distributed by an individual when dealing with a stimulus field, and (b) constricted-flexible, which concerns the manner in which an individual deals with a stimulus field containing contradictory or intrusive information. It was hypothesized that younger children would show a predominance of scanning and constriction while older children would show a predominance of the focusing and flexible controls.

Method: 60 public school children were divided into three age groups (6, 9, and 12 years) and were matched for average IQ (CMMT) and normal visual acuity (Visual Acuity Chart of the American Optical Company). (a) To test the scanning-focusing measure, a circles test was used on which the subjects had to state if the circles were equal or if one was larger, (if so, which one?). Indication of scanning was seen if subjects overestimated the difference. (An individual devoting a prolonged concentration on one instead of systematically comparing both will overestimate the difference.) (b) To determine a constricted-flexible measure, a fruit distraction test was used in which the experimenter was presented a card of fruits to be read orally, giving the colors of the fruits. He was then asked to read a second card, in which achromatic line drawings of food and nonfood objects were placed alongside of the fruit. Three measures were gathered: (1) reading time distractibility score (time to read card II minus card I), (2) reading error distractibility score (reading errors of card II minus card I), and (3) number of intrusive stimuli recalled. It was assumed

that subjects taking significantly longer to read the "distraction" card make more errors and recall more of the instrusive cues, cannot selectively withhold their attention from the intrusive information (achromatic drawings), and are thereby disrupted by it (constricted control).
Results: (1) ANOVA--between size estimates (scanning-focusing) and age was significant at $p<.01$ level in which the older child estimated more accurately. (2) a. Reading Time Difference Scores-- significant between age groups in which the youngest had the greatest reading difference. b. No significant correlation between sex and age mean Reading Error Difference Score. c. No significant correlation between age and amount of intrusive objects recalled. (3). Significant Intercorrelation of Measure Cognitive Control. a. Circles Test and Reading Times Difference= $r=.25$ ($p<.05$ level) b. Circles Test and Number of Recalls = $r = .42$ ($p<.01$ level) c. Reading Time Difference and Reading Error Difference= $r = .38$ ($p<.01$ level) d. Reading Time Difference and Number of Recalls = $r = .27$ ($p<.05$ level).
Conclusions: Circle Test -- (1) "The youngest subjects deploy attention unsystematically while the older subjects, relatively more systematically, with 9-year-olds falling between." (2) "The younger children had significantly more difficulty selectively withholding their attention from'intrusive objects' (constricted control) with the older children showing progressively less difficulty in selectively devoting attention to the central stimulus (flexible control)." (3). "The three measures of the constricted-flexible control contribute to each other some degree of reliability and validity." Subjects who tended to make poor size estimations also tended to be more disrupted by the distractions of the fruit test. (4) Authors would like to measure eye movements for both tests.

4.3.4 INTERVENTION

4.3.4.1 Gray, S., and Klaus, R. An experimental preschool program for culturally deprived children. Child Development, 1965, 36, 886-898.

Purpose: "To see whether by specifically planned techniques it is possible to offset the progressive retardation of culturally deprived children in their aptitudes toward achievement in the area of perceptual and cognitive development and language."
Subjects: 87 southern Negro children randomly divided into three groups of 20 each and one group of 27 in 1962 when they were 3 1/2 to 4 1/2 years old. Group I has had three special summer schools of 10 weeks each and weekly contacts throughout each year with a home visitor. Group II has had two summer experiences and 2 years of home visits.

Group III (the local control group) has only had all tests. Group IV (27) distal controls live 60 miles from the other children and have only received all pretests and posttests. Assessment: measures used were the Stanford-Binet (five successive testings), the WISC, the Peabody Picture Vocabulary Test (three times), and the Illinois Test of Psycholinguistic Ability (two testings). Design: Each of the two experimental groups had a specially trained teacher and four assistants; so there were 4 to 6 children to each adult in the 10-week summer session. "Normal nursery school materials were used to promote achievement motivation, to stimulate language development, to encourage the child to order and classify the objects and events of his world." Examples: "Children encouraged to build tallest towers they could" to develop persistance toward a goal. They exclaimed over their successes "...in an effort to get the children to take pride in their work and to internalize some standard of excellence." The control groups received only the summer pretests and posttests.

Findings: (1) Binet IQ scores for the training groups increased and maintained their increase for 27 months from May 1962 to August 1964, while the control group's IQ's decreased -- differences between control and experimental groups were significant at $p < .05$ level and beyond. (2) When tracing the hypothetical curves of intelligence for the first treatment group and the distal (60 miles away) control group, the experimental group's observed scores are higher than expected for someone at their beginning level; with a starting IQ of 86, their performed curve shows gains expected from someone with IQ of 100. "In the distal control group, the IQ observed compared with the hypothetical IQ curve indicates a clear case of progressive retardation." (3) Differences on the Peabody Picture Vocabulary Test between the experimental and control groups are significant at .05 level. (4) On the August 1964 testing (after third summer) of the Illinois Test of Psycholinguistic Ability, the experimental children are significantly ($p < .05$) superior to the control children. (5) On a preschool test battery given to all entering first grade, the experimental children did conspicuously better than the controls and tend to approximate the nondeprived children in school.

Conclusions: "By manipulating the variables of achievement, motivation, delay of gratification, and some aspects of perceptual development, cognition and language, the school performance of the experimental group may be considerably improved. This occurred using an intervention program that is developmental rather than remedial and stresses the competencies and motivational patterns demanded by complex present-day society."

4.4.3 MEASUREMENT AND TECHNIQUES

4.4.3.1 Bogartz, R.S. Sequential dependencies in children's probability learning. Journal of Experimental Psychology, 1965, 70, 365-370.

The two experiments described investigate the usefulness of a linear operator model for probability learning in preschool children. For Experiment I, 24 children aged 4 years 3 months to 5 years 7 months were run individually on a two-lever, marble-releasing device. The subjects were told to press one lever only every time they heard a buzzer, which sounded for 3 seconds every 5 seconds. They were told that they would not be right all the time. Reinforcement frequency conditions for half the subjects were 80:20 and for the other half, 50:50. Experiment II used 16 subjects, 12 of whom had been included in Experiment I 5 months previously. In Experiment II, the experimenter was different, and the marble-dispensing apparatus was camouflaged. The subject was told he could win a prize by correctly guessing the color of the marble to be released.

Results from Experiment I, in the form of six sequential statistics for each subject, revealed strong alternation behavior or position preference for several of the subjects, and the statistical model being used was not appropriate or coincident with the results. Experiment II was designed to decrease the likelihood of having the subjects use such response-response dependencies. In the results there were no individual, idiosyncratic response patterns, and therefore an additional analysis of sequential dependencies, in terms of a linear operator model, was performed. The present results support the hypothesis that habits established prior to the experiment may be transferred and be partly responsible for difficulties in using the linear model to account for sequential effects. The results also suggest that some of the difficulties with mathematical models for probability learning can be avoided with less complex subjects; that for preschool children, a simple learning model gives an adequate description of behavior of this sort. In these two experiments, when a motor response was caned for (Experiment I) alternation behavior occurred; when a verbal response was required (Experiment II) there was no alternating behavior, and such findings are supported by other experimental work with children of similar age. Some of the differences might also be due to the difference in reinforcement and the use of experienced subjects in Experiment II.

4.4.4 INTERVENTION

4.4.4.1 Karsh, E. B., and Williams, J. P. Punishment and reward in children's instrumental learning. Psychonomic Science, 1964, 1, 359-360.

> This study investigates the effectiveness of punishment on learning in kindergarten children. Most of the evidence for the indirect effect of punishment comes from animal studies, with the theory that punishment suppresses the undesired habit. Studies with children as subjects in discrimination choice situations show that punishment alone, or with reward, is more effective than reward alone. The test situation in this study, as in many social training situations, involved punishment of certain behavior with no specified alternative open. Apparatus consisted of a 6-foot box with a weighted lever which the subject had to push from one end to the other. A green light signalled the beginning of the trial, and a red light flashed when the lever reached the end, and an M&M candy reward was produced. Each subject had 10 trials on task performance per day. Punishment was a short, loud tone plus verbal disapproval of the experimenter. There were three conditions: (1) Control (14 subjects) 5 days rewarded training, 2 days no reward (extinction). (2) Late punishment (19 subjects) 3 days reward, 2 days punishment and reward, 2 days extinction--no punishment or reward. (3) Early punishment (11 subjects) 1 day reward, 2 days punishment and reward. A measure of total time, from the initial green light until the lever reached the end, was divided into starting time (green light to first movement of lever) and response time (time of lever movement).
>
> Results: The controls' starting speed increased over the first 3 days ($p < .005$) as did the response speed ($p < .02$) and the total speed (p .005). Then followed a slightly negatively-accelerated learning curve. The late punishment group did not differ significantly from the controls; responses were not suppressed due to punishment. The early punishment group showed a definite, persistent decline in total speed throughout the second day of punishment (compared with controls and late punishment $p < .005$). The decrease in total speed was reflected in both submeasures but only the suppression of the response speed was significant ($p < .005$). That increased training, condition 2, produced complete resistence to punishment contradicts findings of rat studies, but it is in accordance with the simple theory that an increase in the number of rewarded trials should increase habit strength and resistance to punishment. The controls and late punishment groups showed little extinction indicated by no decline in response speed when the reward was removed (although there was a significant decrease in the starting speed between the last day of rewarded training and the second day of extinction). The authors conclude that the suppressive effects of punishment on children may be partly or wholly mitigated by

sufficient pretraining and that extraction from animal studies of the effects of reward and punishment on learning in children is not necessarily appropriate.

4.4.4.2 Spiker, C. C., and Lubker, B. J. Experimental tests of the hypothesis of stimulus interaction. Journal of Experimental Child Psychology, 1964, 1, 256-268.

This is a presentation of the results of four experiments to test the implications of the hypothesis of stimulus interaction; i.e., the rule for combining conditioned and generalized habits and inhibitory tendencies of stimulus components to obtain the total habit of a multidimensional stimulus: "if a stimulus component has acquired a specific habit loading, as a result of having been presented within a reinforced stimulus compound, its (the component(s) contribution to the loading of the new compound will be less if the new compound contains components different from those in the original compound." Subjects were preschoolers and first graders.

4.4.5 PATHOLOGY

4.4.5.1 Sanders, B., Ross, L. E., and Heal, L. W. Reversal and nonreversal shift learning in normal children and retardates of comparable mental age. Journal of Experimental Psychology, 1965, 69, 84-88.

The purpose of this study was to investigate the differences between normal and retarded children of the same mental age in a learning situation. Mental age was determined by the Peabody Picture Vocabulary Test. Subjects were 48 normal third grade children and 48 mentally retarded children. The design was a 2x3x2x2x2x2 factor design; i.e., IQ (normal versus retarded), three different conditions following the learning of the original problem, two dimensions on the transfer (color and form), two cue sets within each dimension, two values for each cue in each set (positive or negative) and sex. Following the learning of the original problem, children from both IQ groups were trained in one of three shift problems: R (reversal), in which positive and negative cues were reversed and two new irrelevant cues introduced; NRO (nonreversal, old), in which the previously irrelevant cues were now relevant and two new irrelevant cues were introduced; NRN (nonreversal, new), in which relevant cues from an old, irrelevant dimension were drawn, but no new cues introduced. The results were reported as showing reversal learning significantly easier for normal children than either of the nonreversal situations. This reversal-nonreversal difference was not significant for the retarded children. The retardates were significantly superior to normals on the nonreversal learning but tended to be inferior in reversal learning. The two nonreversal conditions did not appear significantly different for either the normal or retarded groups, and both types of children found the NRO condition slightly harder than the NRN learning situation.

4.4.6 PHYSIOLOGY, ETC.

4.4.6.1 Gardner, D. B., and Judisch, J.M. Intersensory transfer of training in young children. Perceptual and Motor Skills, 1965, 20, 802.

> The purpose of this study was to see if pretraining in a visual discrimination task would facilitate learning of an analogous auditory task. Subjects were 37 preschool children, 3-3 to 5-1 years, 15 of whom were trained on a two-light, visual sequence to respond to the color of the initial light. The test situation utilized two sounds in the same relationship as the colors and presented in a randomly alternating order. The second group of 22 children were trained to respond to a single light and tested on the same auditory task. Results were significant ($p < .001$) in favor of the first group, indicating significant cross-modal transfer effects. However, a third group which were trained to respond to the final rather than the initial light in the sequence showed no significant transfer effects.

4.4.8 GENERAL

4.4.8.1 Lubker, B. J. The effect of training on cue-position patterning in discrimination problems. Journal of Experimental Psychology, 1964, 1, 135-144.

> The hypothesis put forth is that response patterning increases as a function of the amount of training and that patterning facilitates performance on a problem containing previously reinforced components. In discrimination learning Spence assumed that the response is conditioned to each component of a compound in a simultaneous discrimination problem. The solution of successive discrimination problems requires differential responses to the cue-position patterns or arrangement within the compound.

4.5
CONCEPT DEVELOPMENT

4.5.1 NORMATIVE

4.5.1.1 Davies, C.M. Development of the probability concept in children. Child Development, 1965, 36, 779-788.

This study seeks to clarify some questions raised by previous probability concept experiments, specifically those of or inspired by Piaget. Hypotheses tested are that (1) "acquisition of the concept of probability is a developmental phenomemon," (2) "nonverbal behavior of the preoperational child is often consistent with the inference that he is responding to event probabilities," (3) "nonverbal behavior reflecting event probabilities appears earlier than does verbalization of the concept" or its application, and (4) there is a sex difference in the extent of behavioral expression of the concept between ages 3 and 9 years.

Subjects were 112 children from public schools in Columbus, Ohio; eight boys and girls at each age level, 3 to 9 years inclusive. Two sets of materials and measures were used: Nonverbal--a two-choice lever-pressing device holding two glass cylinders, one of which contained 4/5 red, 1/5 white marbles, and the other the reverse combination. The stated object was to obtain five marbles or specified "payoff" color in 10 trials in order to win a prize. Five red and five white marbles (in random order, except that the last one was of payoff color) appeared in response to lever-pressing. The actual color reward proportions were 1:1 in an attempt to preclude the child's learning the probability concept, or what Piaget called liberating a preexisting idea. For each age and sex division, the order of color sequence was reversed to counterbalance for color and position preference. The measure in this test was the number of maximum-gain responses during 40 trials. Scores above 25 would differ from chance responding and were interpreted as relating to apparent (visual) event probabilities and counted as "passing." Verbal--five small boxes containing plastic balls or marbles, in color proportions of 4/5 and 1/5 were presented, and subject was asked for each, which color he thought he would draw if he chose an item from the box with his eyes closed and why he thought he would get that color. After trial five, subject was asked which color he would get if the object was replaced, the box shaken and another item drawn and why. For each trial, "pass" consisted

consisted of indicating the prevalent color and reasoning that the choice was influenced by the relative proportions of the two colors. Responses in trial six were counted if the reason given was that sometimes the less prevalent color would be chosen by chance. The entire test was scored 1 or 0, with a minimum criterion of acceptable prediction and reasoning on at least the last four trials. Two judges scored the verbatim recordings of the experimenter's responses.

Results: Two functions appear to develop: the percentage of subjects passing the nonverbal test increases up to a maximum of 6 years, indicative of a relation between subject's behavior and event probabilities. Verbal ability to apply the concept in specific situations appears at 5 years and is displayed by 100 percent of the 9-year-olds. All children who passed the verbal test also passed the nonverbal one. An ANOVA on mean ages of subjects, excluding 9-year-olds, passing neither test ($\bar{X}$=3-11, N=16), nonverbal only ($\bar{X}$=5-4, N=44) or both tests ($\bar{X}$=7-4, N=36) was significant ($p<.01$), and all differences between means were significant at $p<.05$ level. Seventy-five per cent of the 64 subjects in the preoperational range, 3 to 6 years, passed the nonverbal test, and 10 of these also passed the verbal test. Nonverbal behavior in accordance with event probabilities was seen to precede an ability to verbalize, but no children who could verbalize the concept failed the nonverbal test. All of the first three hypotheses are supported at the $p<.05$ level of confidence. The only significant sex differential was on a test for the difference between proportions, in favor of girls at age 7 on the verbal test ($p<.02$). The author concludes that there is a developmental trend in behavior consistent with event probabilities, and that verbalization and application of the concept should be investigated in relation to other variables such as mental age, IQ, socioeconomic status, etc.

4.5.1.2 Elkind, D. The development of quantitative thinking: a systematic replication of Piaget's studies. *Journal of Genetic Psychology*, 1961, 98, 37-46.

Problem: This is a replication of one of the groups of studies reported by Piaget in *The Child's Conception of Number* (1952). Piaget had sought to trace the developmental changes in the form and content of the child's quantitative thought. He had distinguished 3 types of perceived quantity by which things can be compared without actual measurement: (1) gross quantities: single perceived relations between objects (e.g., longer than); (2) intensive quantities: single perceived relations taken 2 by 2 (e.g., longer and wider); and (3) extensive quantities: unit relations between objects (e.g., X is half of Y). Piaget had subjects of various ages comparing two amounts of material several times, with the material arranged so that a successful result required, at different times, the comparison of gross, intensive, or extensive quantities. Piaget claimed to have found 3 age-related, hierarchically ordered stages of success in comparing quantity: Stage I (age 4)--children at this stage could only succeed at comparing gross quantity; Stage II (age 5)--children at this stage could succeed at comparing gross and intensive quantity; Stage III (ages 6 and 7)--children at this stage succeeded in comparing all three quantities. Elkind's rationale for replicating this work is that, while these are significant experiments, many of them are "devoid of statistical methods and systematic design." Elkind purports to test the following seven hypotheses in this study: (a) age groups (4, 5, 6, and 7) differ significantly in their success in comparing quantity; (b) the type of quantity required by the test affects successful comparison; (c) the type of material also affects successful comparison; (d) age and type of quantity jointly affect successful comparison; (e) type of quantity and type of material jointly affect successful comparison; (f) there is a positive correlation between performance on the 3 types of material; (g) there is a positive correlation between success in comparing quantity and performance on the W.I.S.C.

Subjects: 80 children, in three groups as follows: 18 at age 4, 40 at age 5, 22 at ages 6 and 7.

Procedure: All subjects were tested on three types of material (sticks, liquids, and beads) for the three types of quantity (gross, intensive and extensive). The tests were structured as 'games' and are described. Each subject was tested twice with the same material, and since there were three types of material, there was a total possible score of 18 for each subject.

Designs: A 3X3X3 analysis of variance design was used to test the major hypotheses regarding separate and combined effects of age, type of quantity and type of material.

Findings: (1) Age: overall F for the effects of age was 56.88 ($p < .01$). Elkind concludes that this finding, that success in comparing quantities increases with age, is in agreement with Piaget. (2) Type of Quantity: overall F was 480.90 ($p < .01$). Gross quantities were easiest to compare; intensive, next easiest; and extensive were hardest. This result is seen to agree with Piaget. (3) Type of Material: F was 48.00 ($p < .01$). Liquids were most difficult to compare. Piaget had only suggested this; he had not reported it in his findings. (4) Interaction of Age with Type of Quantity: F was 35.57. While the order of difficulty for types of quantity was the same at each age, the difference in difficulty decreased with age. Elkind concludes that "this agrees with Piaget's finding of age-related, hierarchically ordered stages in the development of success in comparing quantity." (5) Interaction of Type of Quantity with Type of Material: F was 15.17 ($p < .01$). (6) Correlations for three types of Materials: Intercorrelations were all "high and significant." This result is seen to support Piaget's assumption that comparisons with different materials tap the same conceptualizing ability. (7) Comparison and W.I.S.C. Score Correlations: These correlations were "generally positive, sometimes significant and usually low."

Discussion: Elkind presents a brief note on Piaget's conception of these stages in comparison as representing steps in the development of the form and content of children's quantitative thinking. In sum, these three developmental steps are seen as concurrent with the three stages in comparison. Piaget refers to them as a "global," "intuitive," and "abstract" conception of quantity. The development of certain mental operations are also seen by Piaget to accompany the stages of success in comparing quantity. It is the development of "logical multiplication" which promotes the step from Stage I to Stage II, and the development of "equation of differences" which promotes the step from Stage II to Stage III.

4.5.1.3 Elkind, D. Children's discovery of the conservation of mass, weight, and volume: Piaget replication study II. Journal of Genetic Psychology, 1961, 98, 219-227.

Problem: This is the second in a series of Piaget replication studies by the author. The present study deals with one of the experiments described in "Le Development Des Quantities chez L'Enfant" (1960), dealing with the ages at which children discover the conservation of mass, weight and volume. It attempts to standardize Piaget's procedures and to introduce statistical design. The purpose of Piaget's study was to determine whether the child could tell that a quantity remained the same (was conserved) after it was changed in appearance. Two clay balls, identical in size, shape, and weight, one of which was later made into a sausage, were used. Piaget tested 5- to 12-year-old children and found that conservation of mass was discovered at ages 7 or 8; that conservation of weight was discovered at ages 9 or 10, and that conservation of volume was discovered at ages 11 or 12.

The present study tested the following hypotheses: (a) that the number of conservation responses does not vary significantly with the type of response (prediction, judgment, and explanation) required; (b) that the number of conservation responses varies significantly with the type of quantity (mass, weight, volume); (c) that the number of conservation responses varies significantly with age level; and (d) that the number of conservation responses varies significantly with the joint effect of type of quantity and age level. Children's explanations of their responses were also compared with those of Piaget's subjects.

Method: Subjects were 175 elementary school children, 25 each from kindergarten to sixth grade. Each subject was questioned three times on each type of quantity. For each quantity, subject was asked to predict, then judge, then explain his response. In the test for the conservation of mass, two identical clay balls were used. Subject was asked to predict conservation before the shape of one was changed; after the change was made, subject was asked to judge whether the balls now had the same amount of clay; and lastly, subject was asked to explain his response. The same procedure was used to test for the conservation of weight and volume. Each conservation response was scored one, and each nonconservation response was scored zero, with a total possible score of nine for each subject. Lindquist analyses of variance designs were used to test for the effects of type of response and for the separate and combined effects of age level and type of quantity.

Findings: The F for type of response was not significant, which agrees with Piaget's use of the three types of responses as equivalent signs of conservation. The F for type of quantity was 255.55 ($p < .01$) and agrees with Piaget's finding that the conservation of mass is easiest to discover; of weight, more difficult; and of volume, most difficult. The F for age level was 14.38 ($p < .01$) and agrees with Piaget's findings that conservation responses increase with age. The interaction F for effect of type of quantity and age level was 6.93 ($p < .01$), which agrees with Piaget's findings that age group differences varied with the type of quantity in question. (For mass, the 5- to 6- and the 7- to 11- year-olds differed significantly; for weight, the 5- to 8- and the 9- to 11-year-olds differed significantly; and for volume, the 5- to 10- and the 11-year-olds differed significantly.) Elkind reports somewhat lower percentages of those passing each test at each age level than Piaget found but suggests this could be due to the small size of samples used in the present study and the somewhat different procedure used in his test for conservation of volume. In comparing the types of explanations given by the children in his study with those of Piaget's subjects, Elkind found the same types and age trends in the explanations given by his subjects. He classifies nonconservation explanations as either "romancing" or "perceptual," and conservation explanations as either "specific" or "general." In general, the explanations given by the child indicate that as his thinking develops, it "frees itself from its earlier domination by immediate perception."

Conclusions: Elkind concludes that his results agree with Piaget's findings regarding the ages at which children discover the conservation of mass, weight, and volume. The conservation of mass did not usually appear before 7 or 8; conservation of volume did not usually appear before 9 or 10; and conservation of volume did not usually appear before age 11. The author briefly presents Piaget's interpretation of these results. Piaget's theory is that concepts of quantity develop in three stages, with the discovery of conservation occurring during the final stage. Children at the first stage judge quantities by single dimensions which they are unable to coordinate, one with the other. At the second stage, they are able to judge quantity differences two by two (long-wide, long-narrow). Piaget calls this "logical multiplication." But they are unable to resolve the contradiction between the two and therefore give non-conservation responses. At the third stage, children have an abstract quantity concept and judge quantity in unit terms and are able to predict and judge conservation. It is the "equation of differences" (what the object gained in length it lost in width) which underlies this abstract quantity and number concept formation.

The time lag between the discoveries of the different types of quantities (mass, weight and volume) Piaget attributes to the difficulty the child has in conceptualizing the quantity; and this, in turn, is due to the degree to which it is associated with the subject's own action. Therefore, Elkind concludes, "the discovery of conservation is limited both by the maturational level of the subject and by the properties of the object and in this sense it is both a nature and a nurture theory."

4.5.1.4 Elkind, D. The development of the additive composition of classes in the child: Piaget replication study III. Journal of Genetic Psychology, 1961, 99, 51-57.

Problem: The present study replicates one of the investigations reported by Piaget in "The Child's Conception of Number" (1952), dealing with the child's ability to additively compose classes (include partial classes within a total class). The purpose of Piaget's experiments was to determine whether the child could tell that the number of elements in a total class was greater than the number of elements in one of its subclasses. Piaget had found three age-related stages in the development of the ability to include classes. At the first stage (usually 5 and 6), children had a general impression of a total class, but when forced to compare part against whole (the brown wooden beads compared with all the wooden beads), they behaved as if the whole class was "destroyed" and compared one partial class (brown beads) with the other partial class (white beads). At the second stage (age 5 and 6), when children were asked to compare part with whole, the whole was not "destroyed," but identified with the part; that is, they said that the brown beads were "the same" as the wooden beads. At the third stage (age 7 and 8), children had an abstract conception of classes and saw that the wooden beads were more than the brown beads, because there were white wooden beads as well. Piaget also used control tests with total classes having specific names; e.g., boys and girls as partial classes, "children" as total class (unlike the class "wooden beads," which has no specific names). The present study attempted to replicate this test, which was only briefly reported by Piaget, in an attempt to determine whether Piaget's stages were significantly related to age.

Method: Subjects were 100 elementary school children, 25 randomly selected from each class kindergarten through third grade. Each subject was asked: (a) How many children are there in your class? (b) How many boys in the class? (c) How many girls? (d) Are there more boys or girls, depending on sex of subject? (e) What are children? (If they answered (d) incorrectly, then they were asked (e) and (d) again.) Questions a, b, and c were only orienting questions. Responses to (d) were categorized according to Piaget's stages as follows:

If partial class reported as greater than total class --- Stage I
If partial class identical with total class --- Stage II
If total class greater than either partial class --- Stage III

Findings: The percent of children giving stage I, II, or III responses for the four age groups is as follows:

Age	Stage		
	I	II	III
5	50	12	38
6	32	12	56
7	12	12	76
8	8	-	92

(X^2 for all cells in table is 12.59 ($p < .05$.)

Elkind concludes that the "stages were related to age in agreement with Piaget's findings." The small percent of subjects at stage II was unexpected, and he suggests that since it is a transitional stage, it is perhaps shorter in duration or does not occur at all in some children. Elkind also points out that although children at all stages were able to give verbal definitions of the class "children," at the first and second stages, they could not dissociate and compare the part with the whole; he suggests that "success in comparing classes quantitatively is probably a better index of the ability to include classes than is a qualitative verbal definition."

Conclusions: Elkind summarizes Piaget's interpretation of the three age related stages in the ability to additively compose classes in the following way. The difficulty at stages I and II may be explained in two ways: either that the child is unable to think of the same set of elements in two classes at once (boys and children) or that he is unable to think of a single element possessing two properties at once (something which is a "boy" cannot also be a child.") These difficulties with extension and intension, Piaget attributes to the irreversibility of his thought. Once the child has conceived a set of objects as being in one class (or possessing one property), he cannot return to the starting point of his mental operations and reconceive the same set of objects as being in a second class (or possessing a second property). While the irreversibility of the child's thought is the psychological explanation, Piaget also holds that logically, the child's inability to include classes derives from his inability to "group" operations, so that the whole remains the same whatever its relations to the parts. The concept of "grouping" of operations seems to imply a coordination of one operation with another, but this is not spelled out by Elkind in any detail.

4.5.1.5 Elkind, D. Children's conceptions of right and left: Piaget replication study IV. Journal of Genetic Psychology, 1961, 99, 269-276.

Problem: This is a replication of an experiment of Piaget's (1929) in which Piaget had used standardized tests and statistical procedures, with 5- to 11-year-old children, and found three stages in the development of right-left conceptions. The purpose of this study was to compare these results with those on American children.

Method: 210 Jewish children were studied from a population attending a day camp, 30 subjects at each year level, from 5 to 11, ethinically homogeneous but socioeconomically heterogeneous. Six tests were used, of increasing difficulty, each consisting of several questions, asking the child to discriminate between his right and left leg, hand, etc.; the observer's right and left hand, leg, etc.; the relation of one object to another (Is the pencil to the right or left of the penny?); and changes in relation due to changes in the subjects position. A test was passed only if all its questions were answered correctly.

Results: Piaget had reported the age levels at which 75 percent of his subjects passed each test. The results of this study show that there was no more than a year's discrepancy between the results at each age level, although Piaget did not report the number tested at each age level. The tests in both studies were passed with increasing frequency with increasing age, and Elkind therefore agrees with Piaget that the tests are developmental measures. Piaget had distinguished three stages in the development of right-left conceptions, but had not elaborated on them. Elkind gives his own formulation of these stages as follows: Stage I (up to ages 7 or 8): the child's conception of right and left is both underdifferentiated (i.e., he can't distinguish his own right and left from that of a person facing him), and overdifferentiated (i.e., he can apply right and left to arms and legs but not to objects. He has a nondifferentiated and global conception of right and left. Stage II (from 7 or 8 to 10 or 11): child has a concretely differentiated conception of right and left. He can perform the two above-mentioned tasks but fails to "completely dissociate right and left from the objects to which they referred." They are able to dissociate their right and left judgments from objects only if some perceptual prop (another person or change of position) is given. Stage III (ages 10 or 11): They usually have a "fully differentiated, abstract conception" of right and left. They can see that the middle one of three objects was both "to the right" of one and "to the left" of the other. In other words, they are aware of the relational character of right and left. Elkind comments that in both his and Piaget's studies for young children right and left were not relative positions but absolute properties of things and that the children had difficulty in forming abstract relational conceptions.

Conclusions: Elkind briefly summarizes Piaget's interpretations of his results. Piaget had tried to show that relational conceptions of right and left are dependent upon the "socialization" of thinking, which also develops in three age-related stages. In the first stage, it is the child's egocentric tendency which prevents him from distinguishing another person's right and left from his own. At the second stage, children are able to take other people's viewpoints one after the other but not simultaneously. Finally at the third stage, they can conceive how an object can be both "to the right" and "to the left" at the same time because they can coordinate all possible points of view. But Elkind concludes that "even though the socialization interpretation has observational support and is intuitively appealing, it lacks vigor." He states that Piaget also had a biological interpretation of this development, which he gave in the 1929 book, but since then it has undergone extensive revision. Elkind chooses therefore not to present this early biological interpretation and doesn't offer the later one either for "the job of interpreting the results of Piaget's early investigations in view of his later theorizing is a major task for the future."

4.5.1.6 Elkind, D. Discrimination, seriation, and numeration of size and dimensional differences in young children: Piaget replication study VI. Journal of Genetic Psychology, 1964, 104, 275-296.

Problem: This is a replication study of some experiments described in "The Child's Conception of Number," specifically those relevant to discrimination, seriation, and numeration of size differences. Piaget's experiments were aimed at demonstrating stages in the development of particular conceptions--that of a series and a seriated class (number)--and also demonstrating the development of a conceptualizing ability that transcends the formation of any particular conception (the unfolding of conceptual abilities) that accounts for the attainment of diverse conceptions. Piaget found that the discrimination problems were passed at the 4-year level but that the more complex of the seriation and numeration problems were not passed till 6 or 7. He also discerned three stages in children's ability to seriate and numerate size differences. The purposes of the present study are threefold: (1) to see if similar stages could be found, using standardized procedures and a statistical design; (2) to determine whether the perceptibility of size differences in one-, two-, and three-dimensional materials would affect the ages at which stages appear; and (3) to amplify Piaget's discussion on the development of seriation and numeration, with the aid of concepts and examples familiar to American psychologists.
Method: Subjects: 90 nursery and elementary school children (30 at each age level from 4 to 6), heterogeneous in socioeconomic class and IQ, but the 4- and 5-year-olds may have had a higher level of intelligence, due to their socioeconomic class.

Materials: size-graded blocks, size-graded slats, and size-graded sticks. Tests: child presented with four discrimination problems on each of the sets of materials. He was asked to find the largest and smallest of each set of objects. In the seriation tests, the child was asked to seriate the objects in each set (into a "staircase"). In the numeration tests, the child was asked to count a certain number of objects in each set.
Procedure: each child tested individually three times, each time with a different material.
Results: Age: Analyses of variance was used for comparing success on the three kinds of tests (discrimination, seriation, numeration) at three age levels and with three materials. F for age was 52.5, $p < .01$. Individual T tests were also significant. This increase with age in size of mean scores on all three kinds of tests is in agreement with Piaget's findings.

Tests: Both F test and T tests show significant differences in the means for the three types of tests. The relative difficulty of the three tests, with discrimination easiest, seriation intermediate, and numeration most difficult, is consistent with Piaget. (F was 132.3, $p < .01$.)

Materials: Piaget had suggested that the more perceptible the differences between the materials, the more easily they would be mastered. Elkind tested this suggestion by varying the dimensionality of the materials. The differences between means for materials were significant at the .01 level by both F and T tests, with a trend toward easier discrimination, seriation, and numeration of size differences with this increase in dimensionality. (F was 24.1, $p < .01$.) This finding agrees with Piaget's suggestion. Tests X Materials Interaction: (F was 4.7, $p < .01$.) Piaget had implied that the effects of varying perceptibility of size differences are more pronounced on difficult tests than on easy ones. As was expected, the effects of materials were different on different tests. (But the effect was least for seriation items--an unexpected finding, which Elkind does attempt to explain.) Some illustrative examples of performances observed in this study are described here by Elkind, one at each age level, to serve as a bridge between the statistics which preceded and the theoretical discussion which follows.
Discussion: According to Piaget, conceptualizing ability derives from the internalizations of the child's own actions. Elkind, in this section, attempts to "recapitulate Piaget's interpretation, to extend it and to make it more concrete." A brief precis of this discussion follows: (1) Development of Seriation: At stage 1, the child has only a general impression of a series, as a global figure, in which the whole and the parts are undifferentiated. Child can neither coordinate relations nor form a mental representation of the series. At stage 2, (age 5) the child has now attained an

intuitive representation of the series as a whole. It enables him to construct, by trial and error, a correct seriation in the absence of a model. After it is completed, he can insert additional elements into it--he views it like a jigsaw puzzle, rather than a rank order. At stage 3 (age 6 or 7) the child has attained an operational concept of a series--his internalized actions have taken on the characteristics of logical operations. He can mentally coordinate the relations A B and B C, thus A C, and he can also coordinate these in two directions (C B A) at once. Also, he attributes to his perception of a series (a stairway) his own mental activity, whereas previously he merely read the perceptual givens, which he couldn't do on the plane of perception or intuition. He can now mentally order a series in two directions at once and attributes this dual relation to particular elements. This explains why he can now insert new elements into the series. (2) The Development of Numeration (assignment of numerals to elements regarded as classes and ordered): He parallels the development of seriation and classification, because they involve the same coordinations. Development of number is an attempt to coordinate asymmetric, or series, relations with symmetric, or class, relations. At stage 1, counting is an imitation of adult behavior and not a true coordination of class and order relations. At stage 2, the child has an intuitive representation of seriated class which cannot be "imaged" at the same time, since both are similar in appearance and different in size. At stage 3, the child has attained an operational conception of an ordered class. Ordering and classifying can be carried out simultaneously and this coordination into numerical operations must be achieved by counting. Counting renders the elements simultaneously alike, in that they can be counted, and different, because each has a unique position of enumeration. Counting transforms each element into a unit, and numerical (arithmetic) operations are now possible. The most advanced third stage child can thus solve certain problems by subtraction rather than simply counting. In sum "there is an essential unity between conceptual and numerical ability. Both types of ability derive from an internalization of the child's classificatory and ordering actions that become an integrated set of mental operations with logical characteristics... When the same system of operations is applied to elements both alike and different, the result is number."

4.5.1.7 Estes, B. W. Some mathematical and logical concepts in children. Journal of Genetic Psychology, 1956, 88, 219-222.

Problem: The purpose of the study was to determine whether Piaget's results from his recent explorations in the formation of mathematical and logical concepts in children could be confirmed using some of the same problems with American children. Piaget had found definite stages in the development of these concepts.

Method: Subjects were 52 children, fourteen 4-year-olds, 20 5-year-olds, 18 6-year-olds. Both middle and low socioeconomic class were used. Four of Piaget's problems were presented to the subjects: (1) Subjects were asked to count 10 small green blocks arranged in three different configurations. (2) Subject was asked to fill two identical jars with marbles, then to pour the marbles from one jar into a jar of a larger diameter, then to compare the number of marbles in the two jars. (3) Eight white chips were placed on table and subjects were asked to take an equivalent number of red ones from a box.
Results: (1) Piaget had claimed that children of 5 or 6 have not grasped the idea of conservation of number, so that with change of pattern they cannot count correctly. The author claims that this result was not supported by her study, since "If a child could count at all, he could count the blocks whether they were in a line, a pattern, or piled up." (2) Piaget also claimed to have found that if he spaced the row loosely, the 5- or 6-year-olds thought that the longer row had more chips. The author states that "no states were found in the development of the number concept." She claims that nearly all of her subjects had the correct concept of number. (3) Piaget claimed that before age 7, the child has not attained the conservation of quantity, and that if the number of marbles in one jar is higher than in the other, (in terms of level in the jar) the child thinks the number of marbles has changed. Estes claims this finding was not supported in this study. Although they, at first, answered that the smaller jar had more, when probed, they changed their response to, for example, "No, it just looks like more." In her summary, Estes claims that "no evidence was obtained which supported Piaget's theories as to the development of stages or age levels in the acquisition of mathematical and logical concepts." Also, that the performance of the lower economic groups was the same as that of the middle group.

4.5.1.8 Huang, I. Children's conception of physical causality: a critical summary. Journal of Genetic Psychology, 1943, 63, 71-121.

This paper deals with the question of the nature of physical causation as conceived by the child, and examines critically studies of Piaget on this subject, reported in "The Child's Conception of Physical Causality," as well as a large group of experimental papers appearing subsequent to this, in the hope of "arriving at an integrated view of the matter as warranted by the accumulated evidence."
Review of Individual Studies: Piaget's findings using the "clinical method" are briefly reviewed. Children were asked to explain various natural phenomena, and their explanations were classified into 17 types, of which the following are considered characteristic of children before ages 7 or 8 years: motivational, finalistic, phenomenalistic, participational, magical, moral, artificialistic

and animistic. These are viewed as "structures" of the mind, by which everything is interpreted; physical causality is as yet non-existent. The child's thinking, until this age, is "prelogical" and "egocentric," radically different from that of the adult. (Huang sees this as similar to Levy-Bruhl's theory of the mentality of primitive people.) There is a transitional phase called "dynamic explanation," but conceptions of physical and mechanical causality typical of adults (of which there are also eight types) do not become prevalent until 10 or 11. These stages are regarded by Piaget as universal and inherent in the developmental process, and the earlier structures are said to be "impervious to experience." Huang believes that Piaget's distinction of the early types of causality are unnecessarily refined and refers to all of them, except for magical causality (the belief that the subject's thoughts, etc., can effect changes in the physical world) and phenomenalism (the tendency to take contiguous events as causally related), as "animism" or "anthropomorphism," since they all imply the treatment of physical phenomena like animal and human behavior. (Huang also chooses not to subdivide the range of physical explanations.) In discussing the reports of child biographers, Huang states that although child biographers have long noticed the occurrence of animism and anthropomorphism in children, the diary data "by no means prove that anthropomophism is the typical and universal mode of children's thinking." Werner, who accepts Piaget's view of the explanations of children, draws a close parallelism between the mind of the child and that of primitive peoples, but Huang states that his evidence is too anecdotal and proves as little as that of the biographers.

Some of the more important studies reviewed by the author are the following: Zeininger (1929) found that when the subject matter of the question is within the sphere of the child's experience, a 6-year-old would be more likely to explain it realistically than magically. In a series of experiments by the author himself (Huang, 1930), with children between 4 and 10 years, in which the children were shown strange phenomena having an unexpected or surprising outcome, only a very small number gave magical, anthropomorphic or supernatural explanations. Although the bulk of the explanations were scientifically incorrect, that fact is seen as irrelevant; they were nonetheless naturalistic. They are, therefore, not mystical, but simply naive. Huang concludes that "the child's concept of reality and causality, as revealed under these experimental conditions, is very much naturalistic, factual and logical and... quite similar to that of the adult man in the street."

Susan Isaacs (1930) also arrived at conclusions different from Piaget's and comparable to Huang's. She studied children from 2 to 10 and found that the "clear statements and adequate explanations they offered far antedate Piaget's view of the age at which mechanical causality is at all understood." They seldom showed magical precausality.

Johnson and Josey (1932), who duplicated Piaget's studies, found that their results substantiated few of the claims of Piaget, and they did not find that the child's thought at 6 is characterized by finalism, artificialism, or animism.

Margaret Mead (1932), in her study of the children on the Admiralty Islands, found no spontaneous tendency to animism, and concluded that this type of thought is culturally determined and not the "inevitable concommitant of any stage of mental development."

Osaki (1934), using methods based on Piaget's and Huang's, classified the elicited explanations into "physical" and "prelogical." She found that "prelogical" answers decrease with age, but her use of the term "prelogical" is not clear. These answers are not unphysical or illogical, says Huang. They are somehow merely unsatisfactory. He concludes that in Osaki's data, there is little evidence of dynamic, magical or prelogical causality.

In a study of Chinese children and adults by Huang, Chen and Yang (1935) (not available in English), they found no qualitative differences between the causal thinking of the children and that of the adults; also, mystical and anthropomorphic explanations were almost entirely absent. Two motifs stand out in these explanations: naive physical explanations and the noting of concommitant facts narratively rather than in cause-effect sequence.

J.M. Deutsche (1937) used a written group test method and tried to classify the answers obtained according to Piaget's scheme. Most of the children's responses were classified as naturalistic and phenomenalistic, meaning the tendency to take contiguous events as causally related. Another significant point in this study is that it is more the nature of the specific question which determines the type of response given, rather than the child's general level of causal thinking.

A study by Blachowski (1937) showed the prevalence of some magical practices even among "civilized" adolescents.

Ter Keurst studies superstitious beliefs of school children and college students and found that the incidence of such beliefs does not decline with chronological or scholastic advances but is related to intelligence, socioeconomic status, and other factors.

Russell et al. (1939, 1940), in an important group of experiments, attempted to standardize the clinical method used by Piaget in their studies of "animism," which Piaget defined as "the tendency to regard objects as living and endowed with will." Piaget had also claimed there were four stages of development along this dimension, and Russell found that stages of animism are related to both mental age and chronological age. But Huang is reluctant to accept Russell's conclusions on the grounds that the child's use of the word "living" may be ambiguous and may not imply the attributes of "will" and "moral conscience," which are both necessary conditions of animism, according to Piaget. "We are not sure of the child's usage of the word living; it may simply distinguish the moving from the nonmoving," he says. Huang also states that the child's judgment depends upon "the form of the question, the nature of the explanatory remarks and various other incidental circumstances." Huang concludes that "the animistic attitude is not a generalized, indiscriminate affair, but is induced by certain specific misleading circumstances in the situation."

Summary and Discussion: Huang states that although the child sometimes explains natural phenomena in animistic, dynamic and magical terms, the literature shows that these forms of causality are neither typical, prevalent, nor universal modes of children's thinking before 7 or 8 years of age. He even doubts the existence of "participation," postulated by Piaget, in view of its infrequent mention by other investigators. His argument against the universality of animistic and magical causality runs briefly as follows: since insight into physical causality has been observed even in animals, why not in the child? Since phylogenetically, simple physical concepts are of a lower order of achievement than moral, magical and artificialistic conepts, there is no reason why ontogenetically the reverse should be the case. Huang also argues that while animism, moralism and artificialism develop out of the child's experience with animate and social ways, it seems reasonable to assume that experiences with inanimate objects are equally effective in producing mental structures of a physical sort. He does not attempt, however, to offer some explanation as to when and why animistic and magical explanations do sometimes occur. One reason for their greater incidence in the younger child may be linguistic. The young child's responses are typically vague and equivocal, and may not imply animistic views; he may be simply unable to appreciate the problem of efficient causation as such. In addition to the factor of age, Huang also reviews the following factors mentioned above, which may contribute to animistic and magical explanations: individual histories, the cultural milieu, the method of study, the subject matter of the question, the imaginative moods of the child, the investigator, and the interpretation of the data itself. To sum up, Huang states the "anthorpomorphic, magical and other nonphysical causal concepts are not necessary or general stages in the development of the child's mind, but are relatively rare occurrences obtaining under a certain limited range of conditions. Simple and naive physical concepts seems to be definitely established and predominent even for the youngest of the children studied."

4.5.1.9 Kagan, J., and Lemkin, J. Form, color and size in children's conceptual behavior. Child Development, 1961, 32, 25-28.

Problem: This study was intended as the first in a series on the way in which the child conceptualized his environment. It focuses on the tendency to use form, color, or size in classifying stimuli into conceptually similar groups. The study is in part a replication of an experiment by Honkavaara, who found that with children between ages 7 and 11, more girls than boys used form rather than color as a basis for classifying stimuli into conceptual classes.
Method: Subjects were 35 girls and 34 boys, ages 3, 9 to 8, 6 with median age of 5, 8. All subjects were in either nursery or first grade of an elementary school. Each of the nine stimuli in the series consisted of pieces of white paper upon which were pasted paper cutouts of geometrical forms differing in color, shape and size. There were two or three comparison forms on the top of the paper and a standard stimulus at the bottom. The subject was asked to indicate which stimulus at the top was the same as the one on the bottom.
Results: All subjects preferred form to either color or size, and size was rarely used as a basis for conceptual similarity. There were no statistically significant sex or age differences in choice of color, form, or size, for any one stimulus. However, when subjects were divided at median into young and old groups, it was seen that older girls were less likely than younger girls to choose color, and older boys more likely than older girls to use color. This agrees with Honkavaara's results on 7 to 11-year-olds. Kagan presents a post hoc argument to explain the sex differences between older boys and girls: since the verbal skills of girls are precocious, relative to boys, possibly the girls implicitly apply language labels (square, triangle, etc.) to stimuli more often than boys do and the stimuli are thus more likely to derive their meaning from the label than through the more direct quality of color.

4.5.1.10 Kendler, H. H. The concept of the concept. In A. W. Melton (Editor), Categories of Human Learning. New York: Academic Press, 1964. Pp. 212-236.

This is a theoretical article and review of the literature on concept formation and concept identification. Kendler purports to do three things here: (1) to describe the methods used to invetigate concept learning; (2) to provide an overview of the current scene on research and theory in the field; and (3) to systematize the problems of conceptual behavior in terms of stimulus-response language. The paper is organized into two major sections, the first dealing with the different models, or conceptions, of concepts which different investigators have used in their study of concepts; the second section deals with the nature of concepts, and it is here that Kendler offers some theoretical interpretations of his own.

I. Models of Concepts: (A) The stimulus-response conception of concepts has influenced more workers in the field of concept learning than any other. The stimulus-response language system (stimulus, response, and the association between them) is combined with a behavioristic methodological orientation, which he describes as physicalistic, operational, and experimental. He describes how the conditioning-generalization-extinction model becomes extended to the realm of discrimination learning, and then how discrimination theory tried to bridge the gap between discrimination learning and concept learning. He sees the main difference between the methodology used to study discrimination learning and concept learning as being that, in the former, signle stimulus events are discriminated from each other, while in the latter, classes of stimuli are discriminated. Concept formation is taken to mean the acquisition of a common response to dissimilar stimuli. (However, he does point out that this definition, which makes concept learning continuous with discrimination learning (and the conditioning-generalization-extinction model) is not relevant to Piaget's work with concepts, such as those of time, space, object, causality, etc.) The investigation of concept attainment has taken two directions: one is the discovery of systematic relationships between stimulus events (words, geometrical designs, etc.) and a common response. The other studies the mediational mechanism responsible for concept behavior; the internal cue, instead of the association, is the main focus of attention. Examples of the former are the works of Archer, Bourne, and Brown, Grant, Jones and Tallantis, and Hovland. Examples of the latter are the works of Goss and the Kendlers. (B) Operant Conditioning: Kendler reviews some of the techniques used in this context to study concept learning, and mentions the work of Green, who used verbalization techniques, and Verplanck and Oskamp, who used a card-sorting task, in which the subject was required to state a hypothesis (a dual operant response technique). The Kendlers also have studied how the acquisition of verbal processes influences conceptual behavior, in this context, and he touches briefly here upon his interaction theory about verbalizations and discrimination responses. (C) Clustering: The phenomenon of clustering, although emerging from studies in memory, appear relevant to conceptual behavior. The work of Bousfield, Jenkins, Mink and Russell is mentioned. Various explanations have been offered for clustering; Kendler says the phenomenon illustrates concepts "in action. Words are spontaneously organized into conceptual groups in the absence of any specific instructions." (D) Piaget: A different approach to investigating concepts from stimulus-response psychology. Piaget does not see it as similar to conditioning and discrimination learning. His frame of reference emanates from logic and biology. He sees conceptual behavior in terms of logical operations and traces stages of thought, each of which is characterized by different logical operations--a genetic orientation. Concepts emerge at particular ages (like teeth). Little consideration was given to specific learning experiences. Major attention was paid, not to acquisition of concepts, but their utilization. Kendler refers to the lower standards of experimental control and statistical sophistication in Piaget's work; also that he used verbal responses to the experimenter's questions. Kendler sees Piaget's orientation as supplementary to that of the stimulus-response psychologist, rather than contradictory: stimulus-response has neglected developmental factors; Piaget has neglected the influences of learning. (Piaget's book Logical and Psychology, 1953, seems to be the main source here.) Along these lines, Kendler and Kendler (Psychology Review, 1962) are now attempting to analyze in stimulus-response terms the classificatory and problem-solving behavior of children of different ages. Kendler also thinks that concepts like transitivity, probability, and causality can likewise be studied by behavioristic techniques. (E) Computer Simulation of Cognitive Processes: Newell and Simon's simulation of human thinking by computers: continuous reporting during problem solving, explains its thinking while talking. The question Kendler raises is: Does human problem solving resemble that of the computer, or does the computer simulate human behavior, or is the subject's behavior shaped to resemble that of the computer? His treatment of this subject is brief and skeptical. (F) Mathematical Models: Behavior can also be represented by mathematical models, but these, unlike the computer models, have emerged from the stimulus-response language and methodological traditions. He mentions the work of Bourne and Restle, who restrict their attention to relatively simple conceptual behavior, and whose work is "nonmediational." But Kendler believes that mathematical models will play a more and more important role in studies of classificatory behavior in the future.

II. The Nature of Concepts: In this section, Kendler offers his suggestions for conceptualizing classificatory (conceptual) behavior, using stimulus-response language. He suggests that concepts have three conceptual properties: (1) they are associations; (2) they function as cues; (3) they are responses. By using this scheme, he hopes to order some of the major problems in conceptual behavior. In brief, his ideas run as follows: (1) Concepts as associations:

Learning of concepts has been studied, typically, as the association between dissimilar stimuli and a common response. But many of the studies are really concept identification, rather than concept learning; it may be only acquisition of concepts which is associative. Identification of concepts may be just a transfer of a new response to an old class of stimuli. In this context many unanswered questions are raised, such as the developmental changes occurring in various kinds of concept learning, optimal conditions for concept learning, transfer of learning, etc. (2) Concepts as Cues: A basic difference between stimulus-response correlationists and mediational theorists (like Kendler himself) is that the former are interested in concepts as associations; and the latter, in concepts as cues. The former are primarily concerned with concept formation; the latter, with concept utilization. Various critics of this cue function theory are mentioned. (3) Concepts as Responses: Mediationists say that when a child has acquired a concept, (Goss) he has acquired an implicit response, sometimes verbal, which serves as a cue for his overt behavior. Zeaman proposes an alternative to this stimulus-response mediational theory, having to do with the acquisition of responses (of observing or attention) whose function is to "make effective certain features of exteroceptive stimulation not previously responded to." This is a sort of "perceptual formulation" as opposed to the mediational approach. In concluding this section, Kendler mentions the importance of conceptual behavior to education. What is being learned in programed learning for example, are concepts, and this must be better understood if programed learning is to improve. Three papers on this subject (Gagne and Brown, Kendler, and Silverman) are referred to on the subject. A fairly extensive bibliography, going back to Hull and Pavlov, is given.

4.5.1.11 Kendler, T.S. Concept formation. Annual Review of Psychology, 1961, 12, 447-472.

This is a review article of the literature on concept formation, concentrating on the period from April 1957 to April 1960. Kendler defines concept formation as "the acquisition, or utilization, or both of a common response to dissimilar stimuli." He makes no distinction between concept formation, concept attainment, and concept utilization because these terms are, as of now, used to describe experimental procedures that either overlap each other or are not discriminably different. In a historical review of earlier work, he offers samples of various views in which concept formation was seen to be dependent on the elimination of responses to irrelevant cues. He refers here to the systems of Hull, Skinner, Bourne and Restle, Harlow and Gibson. In these systems, the stimulus equivalence generated in concept formation could be found in some property of the physical stimulus which becomes discriminated from its other properties. However, in contemporary approaches to concept formation, Kendler sees a theme which is common to all: "the focus upon the *internal process* that mediates between the stimulus and the response, between the problem and its solution." He summarizes recent research in concept formation under the following rubrics: (1) stimulus, (2) motivation-reward, (3) response, and (4) genetic factors.

Stimulus Factors

Simplicity-complexity: one way of measuring the simplicity or complexity of the stimulus has been to measure the difficulty or a concept by measuring the ease with which it is acquired. This method has been used to compare qualitative difference like abstract and concrete forms, color, and number (Heidbreder, Grant, et. al.). Wohlwill differentiates between abstraction, which he defines as a selective response to a given aspect of the stimulus, and conceptualization, which he considers a process of mediated generalization. The data indicate that color and number are more easily abstracted than form, but form and number are more easily *conceptualized* than color. Another way of describing the simplicity of the stimulus is to measure it directly, independently of the response. Hovland suggested using information theory for this purpose, i.e., to establish functional relations between measurable aspects of the stimulus and conceptual behavior. Archer, Bourne and Brown used information theory to measure the bits of relevant and irrelevant information provided. Complexity was deemed to be proportional to the amount of irrelevant information provided. The variable of stimulus complexity, along with the variable of stimulus redundancy was studied by Bourne and Restle; Bourne and Haygood find that increases in redundant relevant information improve concept formation and redundancy of irrelevant information interferes with performance.

Spread of Instances: This is the question of whether it is more effective to train slightly on a wide variety of instances of the concept or intensively on a few. Hull found the former to be more efficient, but research on learning sets shows that no difference is obtained by varying the number of trials per problem while holding the total number of overall trials constant. There are other contradictory findings, such as intensive single-problem training produced more transfer in Adams' work, whereas Gallantine and Warren find that the greater the number of training problems, the greater the transfer.

Stimulus element versus relationship: Gonzales and Ross report that children between the ages of 3 and 5 can acquire concept of middle size, despite their inability to verbalize. Other studies are cited on the issue of stimulus element versus relationship, and in general, they show that concepts dependent on relationships can be acquired by monkeys and children, as well as adults.

Motivation and Reward Factors

Motivation: There are relatively few studies of the effect of motivation on concept learning or performance. Kendler's explanation for this is that drive level in human subjects cannot be easily manipulated. Mednick, using the Taylor Manifest Anxiety Scale (MAS) found that high MAS scores (high drive) are positively related to the magnitude of mediated generalization responsivity. The study by Romanow showed that drive operates on mediating responses in the same way as on overt responses.

Reward or feedback: Green, using an operant stimulus discrimination procedure, found that the extent of concept formation was inversely related to the ratio of responses to reinforcement. Other studies confirm a positive relationship between consistency of reinforcement and efficiency of concept formation.

Preliminary training: Preliminary training on a given dimension--e. g., form--yields positive transfer when subjects are shifted to new and different stimuli within the same dimension.

Positive and negative instances: Hovland and Weiss found that more subjects attain the correct concept when it is transmitted by all-positive instances than by all-negative instances. Incidental to these studies of the effects of negative and positive instances Kendler reports the finding of the important role of memory in the acquisition of concepts, when successive presentation of instances is involved. More errors are due to failure to remember earlier instances in such a way as to see their implication than are due to failure to assimilate information perceptually available or to draw appropriate inferences about the concept being sought.

Response Factors:

Although he admits the range of responses employed in concept formation is wide, Kendler limits the present review to two response provinces: the verbal response and efforts to analyze the steps involved in the process of concept formation.

Verbalization: Whorf is the most extreme representative of the notion of the dependence of concepts on language. In essence, all higher levels of thinking involve langauge, and the structure of his language determines man's thoughts, concepts, and views of the universe. Experimental results support the more moderate position that concepts are influenced both by perceptual and linguistic variables. The literature on semantic generalization demonstrates that different words or objects and their names often produce a common response. In this context, the author refers to Pavlov's theory of the second signal system. Man produces words that can act as stimuli, and such stimuli differ qualitatively from others because they "comprehend, generalize and stand for the multitude of separate stimuli of the first signal system" (the external world). Some early Russian studies established conditioned reactions to a stimulus-object and then obtained generalization to its name, and vice versa. The Russians are still working in this area. According to Liublinskaya, a word becomes a signal of the second signal system only when it becomes a concept. Also, he reports that learning of concepts is facilitated, and conceptual transfer is extended, by the use of verbal labels.

Comparisons are also being made on the various modalities in which language may be expressed: the hearing, seeing and pronouncing of words. Positive transfer was obtained from the heard word and the same word presented visually (Ivaschenko). The reverse was not obtained; that is, there was no transfer from the pronounced word to the seen and heard word. Osgood's formulation of the conceptual process has generated another major research trend. The Staatses, using the semantic differential, have developed a conditioning procedure that transfers evaluative responses elicited by words to contiguously presented neutral stimuli. Rhine developed a concept-formation approach to attitude acquisition, in which an attitude is defined as a concept with an evaluative dimension. The mediating function of language in concept formation has also produced a line of research which consists of studying the effect of associating verbal responses to stimuli that will later be used in concept formation tasks. Similar labels aid in concept formation and dissimilar labels aid in discrimination.

Process: One approach to the analysis of process in concept attainment is provided in the research of Bruner, Goodnow and Austin. A sequence of decisions, called a strategy, is involved in selecting the relevant concept from an array of instances presented to the subject. For Kendler, this work is the most highly organized on the analysis of process in recent literature. Johnson also studied process in concept formation, dividing the process into two parts: preparation and solution. An analysis of the acquisition of arithmetical concepts in educationally retarded children which has been made by two Soviet psychologists (Slavina and Galperin) appears to have both practical and theoretical interest. This involved the gradual dropping out of the verbal concommitants of overt responses. Kendler states: "It is an interesting and productive idea that retarded children can help us better understand a process because they need to have it slowed down to the point of recognition.

Genetic Factors

Phylogenetic considerations: It appears clear that animals can acquire concepts. The focus of study now is on what species can acquire what concepts and under what conditions. A large portion of the work is on learning set and reversal learning. Comparisons have been made between rats, adult humans, and children, in reversal and nonreversal shifts.

Ontogenetic factors: There are three major lines of interest here: (1) Piaget, (2) the study of the fole of language, and (3) the methodology of learning set (LS). (1) Piaget: the author offers a brief summary of Piaget's theory of intellectual development, outlining the four main stages and concluding with the comment that "specific fundings are both so numerous and so theory-bound that it is impossible to treat them in the context of this review."

(2) Language: the influence of this area of research stems from the belief that "as children get older their behavior comes increasingly under the control of the stimulation they themselves engender. Their own verbal responses are a most important source of such self-stimulation." Luria has concluded that as the child matures, verbal behavior gradually comes to mediate and regulate overt behavior. After 5 1/2 years, humans tend to operate via verbal control, whereas younger children and animals do not. Not all the data supporting this position are presently available in English. In the United States, there is a rising interest in the relations between language and concept development. The work of Burstein is referred to on the confusion of young children between opposites and similarities. Bousfield studied the amount of recall of a list of words as it relates to the amount of associative clustering. Rudel, Kuenne, and Albert and Ehrenfreund have all studied transposition responses in young children, both verbal and preverbal children. Brown has studied the notion that development proceeds from the concrete to the abstract and has found contradictory evidence. (3) Learning Set: Harlow's general results with children are that preschoolers easily form learning sets on discrimination problems. In general, the results of work by several investigators have shown that this ability to form learning sets is positively correlated with mental age. In summary, Kendler remarks that although the research on concept formation is good, the progress appears small, perhaps because it deals with complex processes that are concealed from direct observation.

4.5.1.12 Kofsky, E. A scalogram study of classificatory development. Child Development, 1966, 37, 191-204.

Purpose: A combination of scaling technique with a cross-sectional approach to individual mastery patterns in the development of classificatory skills was used in order to test further a basic assumption of Piaget's cognitive growth theory; i.e., that there is fixed order of concept acquisition, determined by an increasing ability to use complex logical operations. Inhelder and Piaget (1959) and Morf (1959) provided explanation and data for the partially ordered steps by which children learn class inclusion through experience with diverse attributes of objects to be classified. The author integrates these hypotheses and data with the child's increasing ability to use verbal terms of comparison in a comprehensive discussion of this aspect of cognitive development. She then represents these steps in classificatory development via 11 experimental tasks in order to test two parts of Piaget's theory. Hypotheses: (1) "The order of difficulty of these tasks corresponds to the developmental sequence described by Piaget." (2) "Subjects who have acquired a particular rule have also mastered all the simpler prerequisite rules."

Method: Subjects were 122 children in Rochester, New York schools, of above average intelligence; 10 boys and 10 girls at ages 5, 6, 8, 9 and one additional subject in the 4- and 7-year-old groups. Intellectual level was determined by combination of father's occupation, teacher class ranking, and group IQ scores. Subjects were also screened for defects in color vision, form discrimination, and vocabulary.

Procedure: Individual testing sessions lasted from 1/2 to 3/4 hour (two shorter sessions for youngest subjects), and verbatim responses were recorded and scored later by experimenter.

Tests: The 11 tasks, named below with their scoring criteria and in order of predicted mastery, were presented in random order and involved correct manipulation of geometric blocks and sometimes verbal responses. Labels were those the subjects had spontaneously used during screening: (1) Resemblance sorting (RS): three out of four correct matches of a block in a pattern with two extra blocks, on the basis of form, color, or other stated perceptual quality. (2) Consistent sorting (CS): three or more objects alike in some perceptual feature, selected from array of 12 blocks which could be matched by color or form. (3) Exhaustive sorting (EC): consistent use of one attribute to select blocks which were alike, to fill boxes, one at a time so that all blocks in one box possessed that critical attribute. (4) Conservation (CON): consistent assertion of identity of a labeled class of objects regardless of location because of an attribute which made object a member of that class. (5) Multiple class membership (MM): three out of four correct responses regarding a set of triangles, varying in color and size, as to whether any of the blocks could belong in more than one category. (6) Horizontal reclassification (HR): two complete sortings of eight blocks, once by color, once by shape. (7) Hierarchical classification (VC): correct definition of nonsense term for array of triangles by means of a common attribute and of another term for only some of the objects by an attribute which only they shared. (8) "Some" and "all" (SA): three out of four correct responses to questions about nine blocks of differing color and shape in regard to a superordinate class and its subclasses. (9) Whole is the sum of its parts (A+A'): two out of three correct responses to questions of equivalence about red squares and blue squares in combination. (10) Conservation of hierarchy (B - A'): two out of three correct responses regarding blocks in test nine, when red squares are removed; i.e., remaining blocks are both blue and square. (11) Inclusion (B>A): two out of three correct responses regarding comparison of number of objects in different classes, including a superordinate class and its subclasses.

Results: An ANOVA on individual scores, of number of tests passed, gave significant age effect ($p < .01$) and correlation of age with score ($r = .86$, $p < .01$). The age continuum was divisible into three parts (Turkey's test); i.e., 9-year-olds better than 7- and 8-year-olds better than 4- and 6-year-olds. An analysis of the proportion of subjects passing each task produced six levels, each differing significantly in difficulty from the tasks at the preceding level, as measured by proportion of passes ($p < .05$). These levels were: (1) (RS) and (CS); (2) (EC) passed by majority of 5-year-olds; (3) (MM) and (A + A') demonstrated by most 6-year-olds; (4) (B - A'), (CON), (HR)--most 7-year-olds successful; (5) (B>A) apparent in most 9-year-olds; (6) (VC) mastered by less than half 9-year-olds. "Rank-order correlation of the predicted logical sequence with the obtained sequence of difficulty of the tasks was .87 ($p < .01$)."

A table giving individual patterns of passing and failing tests was drawn up in order to determine if, in fact, subjects solving a given task had succeeded in those tasks thought to be prerequisites. Item-test homogeneity (Loevinger, 1947) showed most items as "sufficiently discriminative to suggest regular stages" in categorizing development; i.e., $H > 0.7$. However, the interitem homogeneity showed at best a partial order in passing all "easier" tests before a given test. "Only 27 percent of subjects passed all the items up to a certain point and failed the rest." By leaving out tasks CON, EC and B>A, a new scale showed 51 percent of subjects with this sort of perfect sequence of passes and failures. Analyses of the types of errors on specific tasks did not produce the significant types of variation which would be expected to occur according to age, and the conclusion was drawn that these data concur with other replications of Piaget's work in revealing individual differences in the mastery sequence of cognitive tasks.

Discussion and conclusion: The scaling technique confounds experimental errors with population variations in development. Variations among tasks may have masked much regularity and those tasks requiring verbalization may be inherently different from those tasks requiring only manipulation. The scalogram model assumes an individual can be placed on a continuum at a point discriminating skills he has mastered from those he has never been able to perform, and thus may not give an accurate developmental measure, since performance of specific operations may vary considerably with situation. Finally the author questions the use of cross-sectional data as possibly fallacious in describing longitudinal development, and suggests "the delineation of the experiences that promote the acquisition of particular operations" as an already useful alternative approach.

4.5.1.13 Lee, C. L. Concept utilization in pre-school children. Child Development, 1965, 36, 221- 227.

Problem: Heidbreder et al. had studied the relative ease with which the concepts of form, color and number were attained by adult subjects and found that the concepts of form, color and number fell along a dimension of difficulty, with number the most difficult concept to attain. The present study investigated the differential ease of concept identification or utilization in preschool children. The six conceptual dimensions studied were color, size, form, number, sex type (objects used predominantly by males or females), and analytic concepts (i.e., similarities based on stimulus componants; e.g., cars with 3 wheels).
Method: (1) Subjects: 90 kindergarten and nursery school children, ages from 3.6 to 6.5 years, in three age groups; mostly middle class. (2) Stimuli: Each item, consisting of a board of 19 by 9 inches, contained three stimuli (familiar toys), two of which possessed similar attributes on the critical concept for that item, with the third having a different attribute on the same dimension. For example, a large blue car, a medium blue car, and a small red car. For this item, color was the critical conceptual dimension; size, the irrelevant dimension. Each concept was represented by five items, making a total of 30 items. (3) Procedure: Subject was asked to tell which of the two stimuli belonged together, or are the same. Candy could be found under the stimulus that did not belong with the others, that was different. One correction was permitted per item, and errors were recorded, with a total of 10 errors possible for each concept.
Results: Analysis of variance showed that the main effects of age, sex, and concepts were each significant. Total number of errors decreased with age (F=25.8, $p < .01$), and girls made fewer errors than boys (F=5.4, $p < .05$). Analytic and sex-typed items produced the most errors, and color and size, the least (F=89.6, $p < .01$). The concept by age interaction was significant (F=9.2, $p < .01$). Six independent analyses of variance were also computed among the three age groups for each of the six concepts (young versus middle versus old group). Each analysis yielded a significant F, indicating that age differences were significant for each concept. (It is interesting to note that color and size differences elicited increased errors with age.) Significant correlations were also obtained between Binet vocabulary score and total number of errors. Lee suggests that the availability of a verbal label for the concept may be helpful in solving the task. Lee concludes that the concepts of color, number, form and size have greater salience; i.e., greater probability of being utilized, for the preschool child, than the concepts related to sex-typed objects or similarities based on

component parts of a stimulus (analytic concepts). With regard to the decreased salience with age of size and color, Lee suggests that this may be due to the fact that the kindergarten child is learning the alphabet and learning to write, tasks which call his attention to form and direction rather than size and color.

4.5.1.14 McKinney, J. P. Hand schema in children. Psychonomic Science, 1964, I, 99.

Purpose: To test the notion that when tactual and visual cues are in conflict in perception of form, visual cues predominate even if they lead to error. This is tested in terms of a young child's hand schema. The hypothesis is that he makes most errors on finger localization when his schema conflicts with the actual position of the hand.
Method: Subjects were 83 normal children; 15, age 4; 20, age 5; 17, age 6; 16, age 7; 15, age 8; and nine blind children, ages 4, 5, and 6.
Procedures: Three experimental conditions: (A) Hand laid on table so that palm is up. (B) Palm up, then turn so palm is down. (C) Palm up, turn palm down, turn palm up again.
Design: Subject has eyes closed throughout. Stimulus: Experimenter touches one of subject's fingers. Response: After three-second latency, subject points to touched finger. During latency, subject turns hand in condition B or C. Each subject is given 10 trials under each condition.
Results: Errors decreased with age in all three conditions. Subjects aged 4, 5, and 6 made significantly more errors (T test, $p < .01$) under B than under A or C. Errors of subjects aged 7 and 8 did not follow this pattern. Blind subjects made significantly more errors ($p < .05$) under C than A. The significance of increase of errors under B compared to A was not tested for blind subjects.
Conclusions: Young child's hand schema is a predominantly visual image. Blind child's hand schema is tactual and kinesthetic. It is not known whether change in older subjects is due to shift in imagery or to the test's becoming too easy for them.

4.5.1.15 Safier, G. A study of relationships between the life and death concepts in children. Journal of Genetic Psychology, 1964, 105 (2), 283-294.

The theoretical background for this study comes mainly from Piaget's work. He defines "animism" in children as the mental phenomenon through which they ascribe life or lifelike qualities to inanimate objects. This arises by means of a fusion of the object with the subject, as the child sees objects as an extension of the self. Piaget postulates a necessary sequence in the development of ideas about life: (1) general activity level, anything that moves is alive (0 to 7 years); (2) life as assimulated to movement (6 to 8 years);

(3) life as spontaneous movement or movement by itself (8 to 11 years); (4) adult view, only plants and animals as alive. Nagy (1948), independently of Piaget's work, found developmental stages in the formation of the death concept which parallel Piaget's: (1) death as a definite fact but only temporary and reversible (0 to 5 years); (2) death life equated with movement by itself (9 years on). The proposed hypotheses are based upon a combination of these theories and findings into three stages: (1) life and death in flux; (2) life as affected by an external agent; (3) life as an internal factor in the object. Hypothesis I--as the individual increases in age, the tendency to attribute animus and death to objects decreases, as the criteria for categorizing improve, and likewise the concepts of life and death become more definite and clearly definable. Hypothesis II--a common rationale blinds concepts of life and death during each stage. Ascribing life to an inanimate object is scored as + animism, and ascribing death to an object is - animism. The test to be used is constructed so that a normal adult would score zero. The dependent variable, then, is the accuracy in applying the terms "alive" and "death." The independent variable is age. Three groups of ten boys each were selected: Group I (4 to 5 years) from the Stanford Nursery School; Group II (7 to 8 years) and Group III (10 to 11 years) from the Ponterosa School in San Francisco. Each subject orally presented with 10 stimulus words and six inanimate and 4 animated objects, which had been heard in the children's verbalizations: dog, ball, tree, bike, boy, moon, mother, ocean, car, cloud. Each subject was asked the following questions about each word and scored one point for each animism response: (1) Does a (stimulus word) live? Is a (stimulus word) living? (2) Does a (stimulus word) hurt when hit? (3) Does a (stimulus word) grow up? (4) Does a (stimulus word) die? An inverview tried to elucidate the rationale behind the responses and was taped.

The interview was judged by two people independently, according to the + or - scores described above on the following questions: (1) Is life or death seen as a recurrent process? (2) Does life or death come from the outside to a person or thing? (3) Is there a basis for considering either process as a recurrent or irrevocable or as an internal event? There were five categories for scoring the responses to each word: flux (life and death as temporary); yes and no (death as irreversible but evitable; i. e., may be escaped); adult and pseudoadult (death as permanent, inescapable; but this concept may be misapplied); undecided--judges did not feel the response was clear enough to put into any of these; contaminated--by the interviewer. Results are shown in the following tables. Generally there was a decrease in animism and death scores with increasing age, and by age 10 or 11, the concepts seemed to be integrated at a higher level. The responses of Group I were spontaneous, unquestioning; of Group II, more reflective, questioning, showed interest in scientific explanation; of Group III, reality-oriented, greater awareness of society, many references to TV.

Mean Scores of Different Age Groups Tested for Concepts of Animism and Death

Concept	Group I (4-5 years)	Group II (7-8 years)	Group III (10-11 years)
Animism	14.6	2.7	1.4
Death	3.9	.6	.3

Number of responses were 60 (two responses by three groups of ten boys per group).

Correlation of Animism and Death

+.67 ($p < .01$) +.44 ($p < .05$) +.87 ($p < .01$)

ANOVA: F value - 52.2 ($p < .05$)

Judges's Scoring of Responses by Category of Scoring and Age Group

[illegible]	Flux	Yes and No	(Psuedo-) Adult	Undecided	Contaminated
Group I	.9	.1	0	0	0
Group II	.2	.7	.1	.1	0
Group III	0	.2	.8	0	0

The author concludes that the results of the judges' scoring seemed to support a common rationale underlying Piaget's stages of animism and Nagy's stages in the development of the death concept and that this study shows a positive relationship between life and death concept formation but does not show the nature of this relationship.

4.5.1.16 Sigal, I.E. The attainment of concepts. Volume I. Review of child development research. Hoffman and Hoffman (Editors), New York: Russell Sage Foundation, 1964.

This is a review article, with a clearly Piagetian orientation, which attempts to describe how concepts are acquired, the psychological processes necessary for their acquisition, and the concepts and conceptual abilities available to children as they develop.
Function of Concepts: The author defines concepts as intellectual tools used to organize the environment and attack problems, and with which appropriate behaviors are associated--either thoughts, motoric acts, or antasies.
Acquisition of Concepts: A complex set of learnings, based on discrimination, perception, transposition and generalization is necessary for concept attainment, and all of these processes are facilitated by language. The author refers the reader to reviews by Stevenson (1963) and G.G. Thompson (1962) for details of the developmental trends for each of these psychological processes. On the basis of such learning, schema evolve which encompass classes of items, and which enable the child to approach the environment in a conceptual way.

Theories of Development: Sigal contrasts two main theories of development: (1) stage-dependent theories; i. e., the belief that development proceeds in a sequential, invariant order. The major exponents of this theory are Goldstein and Scheerer, Tanner and Inhelder, Piaget, Werner, Laurendeau and Pinard, and Kohlberg. (2) The theory which holds that the child is a product of learning experiences, showing different levels of ability, knowledge, and skills as a function of such experience (Ausubel, Estes, Hunt and Sears). He discusses some major arguments for and against each of these positions. A few empirical studies providing empirical support for the stage theory are referred to (Dodwell, Kohlberg, etc.), but the author concludes that the best test of the validity of this theory of the invariant order of concept development would require longitudinal studies; however, at the time of writing, no published studies of this type are available. Sigal raises the question of the effect on stage development of external influences such as teaching. Opinions differ but the author concludes that "evidence on the reaching of concepts, like that on the invariant order of their emergence, is inconclusive."

Stages of Intellectual Development: A description is given of the major stages of intellectual development according to Piaget, and the author provides a fairly detailed summary of the major periods in Piaget's system. His rationale for having chosen this theory is that it "provides the most meaningful system dealing with cognitive development." It is described as a stage-dependent theory in which the child is said to move in an invariant order through major stages and substages. The influence of language on the acquisition of concepts is briefly referred to; the reader is referred to the work of Johnson, Brown, Whorf, Bruner, etc., *in the bibliography* of this article.

Acquisition of Some Common Concepts: The author focuses on the acquisition of certain concepts, those which organize apparent relationships of the physical world; namely, object permanence, space, form, color and size, causality, mass, weight, and volume. The work of Piaget is cited for each of these concepts, as well as many studies reported by others, which are listed in the bibliography, which both support and contradict the findings of Piaget.

Factors Affecting the Attainment of Concepts: The evidence reported in the literature does not present a consistent picture of the correlation between intelligence and concept attainment. Efficiency of concept attainment, however, appears to be associated with higher IQ. Also refers to studies indicating that the degree of retardation influences the level of conceptualization. Inhelder and Woodward refer to several studies on the effect of emotional attitudes, motivational states, states of adjustment, and acquired predispositions on the attainment of concepts; some of the findings are briefly reported. Several studies are cited on the effects of brain damage on concept attainment. Also, studies on the effects of cognitive style on concept attainment are briefly mentioned. Information seeking strategies and their relation to concept attainment are also mentioned.

Effects of Training: A number of studies are cited in which attempts were made to teach new concepts to young children (Smedslund on conservation of quantity, weight, and volume, Beilin and Franklin on conservation of area; Ervin on logical thinking; Welch on hierarchically ordered concepts and Wohlwill and Lowe on the conservation of number). The author concludes from the accumulating evidence that "a child cannot be taught the concept in question until he has already attained a particular cognitive level of maturity." The one exception to this is a piece of evidence reported by Smedslund that cognitive conflict will result in the attainment of a new concept.

Implications for Education: Sigal believes that the most direct application of the findings reported in this review are for curriculum development and for diagnosis of children's intellectual status. Curricula could be organized to take the child's stage of concept attainment into account. Stage-dependent conceptualization can also provide an ordinal scale for diagnosing the child's intellectual ability. Also, since experience and language are so important in the ability to conceptualize, the author believes, "exposure to a wide variety of relevant experiences and encouragement in the acquisition of verbal skills may increase both the quality and quantity of a child's concepts..." Smedslund's cognitive conflect theory suggests that when the child must solve a problem involving juxtaposed concepts, his intolerance of cognitive conflict may be one of the "motivating variables" that influence concept acquisition. Also, Piaget's work suggests that children are often able to solve problems without being able to verbalize them; i.e., intuitively. Teaching techniques might be adapted for this, so that the child does not necessarily have to provide verbal explanations for his solutions to problems; this might be especially relevant for underprivileged groups where verbal facility often lags behind intellectual potential.

4.5.1.17 Wallach, M. Research on children's thinking. Child Psychology (H. W. Stevenson, Editor), 62nd Yearbook, Part I, National Society for the Study of Education, 1963, Chapter 6, pages 236-276.

This paper presents, in summary form, descriptive information that emerges from the research of Piaget and others doing related work on the development of children's thinking. The material is organized according to three age levels: birth to 2 years; 3 to 11 years; and 12 to 14 years. Because of its relevance to the purpose of this abstract, the section delaing with the age period of 3 to 11 years will be dealt with most fully here.

Birth to 2 years: Three major achievements of this period are described: the development of representational processes, means-ends behavior in problem solving, and conceptualization of objects. Representational processes: The earliest reflex-like activities of the infant are quickly modified by learning, through discrimination and generalization. By 3 or 4 months the infant applies each of the responses in his repertoire to an object offered him. These response families, applied to objects, become part of the object's "meaning." Later there develops the ability to internalize these responses to objects. These internalized responses become, with time, more schematic and abbreviated and become useful in problem-solving.
Means-ends behavior (problem solving): At about 8 months, the use of means to secure goals appears, with some understanding of the spatial relations necessary to achieve effects with means-objects. Representational behavior with the referrent absent from the perceptual field is also developing during the second year, aiding the child's comprehension of means-ends relationships, since this ability enables the child to hypothesize causes from observed effects and to anticipate effects from observed causes.
Conceptualization of objects: Before 8 or 9 months, the child shows no awareness of the continued existence of an object when it is concealed from view. Only during the second year does full conservation of the object across spatial dislocation and changes in point of view develop.
Third to Eleventh Year: This section deals with conservation of the following properties across irrelevant changes: amount, weight, volume, horizontality, length, area, number and duration. It also deals with classification of objects, specifically grouping and seriation.
Amount, Weight, Volume: The term "conservation" is defined as the understanding that "no change has occurred regarding one or more aspects of an object or relationship, despite change in other perceivable features." The results of Piaget's experiments suggest that before the age of 6 or 7, perceivable changes in the form of some substance are believed to change the weight, volume, or amount of matter involved. Over the next few years, the concept of invariance in amount of matter is developed, but invariance of weight and volume are slower to develop, with invariance in volume not developing until adolescence. The work of Lovell and Lowell and Ogilvie provide further evidence confirming this transition.

Linguistic factors may influence the ages at which these types of conservation are first exhibited, and the work of Braine, Wohlwill and Lovell, in which attempts were made to minimize the effects of language through a matching-form sample technique are mentioned. Shifts in age norms have also been found by varying the sociocultural status of the children studied (Elkin, Hyde, Pinard, Smedslund, and Vinh-Bang). However, the same general developmental sequences, as found by Piaget, were obtained by such work. The explanation offered for nonconservation at earlier ages is that the child observes changes in certain attributes of the substance, such as length or number of pieces, but does not observe the relation between the attributes; for example, that there are smaller pieces but more of them. The cognitive achievements underlying conservation of amount of matter are seen to be threefold: (1) the ability to take account of the joint effect of two perceived aspects of the material, rather than only one; (2) the conception that matter consists of small particles which can simply change their position with respect to one another; and (3) the ability to hypothesize that a reverse change could be performed. Also, studies have shown that conservation of matter may be held by a child for one kind of material but not for another (Lovell and Ogilvie, Beard, and Hyde), and that experience with different kinds of materials influences the occurrence of conservation. Wallach discusses the findings on the effects of various practice conditions on the development of conservation; specifically, studies concerning number by Churchill and Wohlwill and Lowe; classification studies by Morf; spatial order by Greco; and substance and weight by Smedslund. In general, the effectiveness of a given type or amount of experience is relative to the conceptual attainments already at the child's disposal--a "discontinuity" theory of the effects of experience.

Horizontality, Length and Area: Smedslund's work, following that of Piaget and Inhelder, suggests that only children who showed some initial traces of the horizontality concept profited from experience with invariance in horizontality of water levels in their further development of that concept. Piaget, Inhelder and Szeminska studied the concept of the invariance of length with two sticks of equal length moved so that the relative position of the two front edges are changed. Only by the age of 6 or 7 do perceptual impressions of inequality no longer influence the judgment of the child. Research by Lovell, Healey, and Roland has replicated these general findings on length conservation. Conservation of area was also studied by Piaget, Inhelder and Szeminska. Here again, results suggest an increasing ability to withstand the influence of perceptually prominent but irrelevant features (i. e., the cluttered or uncluttered appearance of equal areas). By age 7 or 8, the child can maintain conservation of area regardless of the differing perceptual configurations. The work of Lovell, Healey, and Roland has confirmed this general developmental sequence.

Number and Duration: Studies by Piaget, Dodwell, Hyde and Wohlwill, and Lowe, with conservation of number, indicate that the ability to enumerate collections of objects by counting does not ensure that the child understands number conservation: when the objects are spaced more closely or further apart, the child at age 5 or 6, thinks there are fewer or more objects than before. A start has been made in the study of sociocultural influences on number conservation (Hyde, Slater) and of the effects of controlled experience (Churchill, Wohlwill, Wohlwill and Lowe). Concerning the effects of controlled experience, some variation in absolute age norms has been found, but not in overall developmental sequences, and the prior existence in the child of supportive perceptual attainments seems to be the crucial factor for the child to benefit from controlled experience. Piaget's work on the concept of duration is briefly mentioned: in general, the young child makes erroneous judgments of temporal order and duration, basing his judgments not on the distance traversed by an object or its velocity, but on the impression of one thing having moved farther in the same direction than another. This "outdistancing" phenomenon has also been studied by Lovell and Slater.

Arrangement of Objects: Classification: Developmental changes in the child's ability to apply principles of grouping and ordering of objects are discussed. Piaget and Inhelder found that the child of 3 or 4 groups objects without overall plan, but by accidents of momentary perceptual impressions, such as form, spatial proximity, or some thema, such as "to make a farm." By 5 or 6, the sorting is more systematic, in that a single criterion is applied to the domain. But the child has still not attained the concept of inclusion-exclusion or subordinate and superordinate classes. The child of this age seems unable to compare one subordinate class with the superordinate class of which the former constitutes a part; for example, brown beads as a part of the class of all wooden beads. The basic experiments of Piaget and Inhelder have been replicated by Elkind, Hyde, Lovell, Morf, and Pinard. Related developmental findings for visual classification have also been reported by Kagan, Moss and Sigel, and Annett.

Arrangement of Objects: Seriation: Various studies suggest that the ability to seriate objects by arranging them in terms of increasing values of some attribute, such as length, tends to emerge somewhere from about 5 to 7 years (Piaget and Hyde). The child's attempts at seriation may be guided by either "piecemeal perceptual comparisons" or by an awareness of the transitivity principle; i. e., a particular element will be viewed as both longer than those preceding it and shorter than those following it. Braine and Smedslund have studied the emergence of this transitivity principle. Smedslund found that by the fifth and sixth years, children do not yet possess and understanding of weight transitivity.

Twelvth to Fourteenth Years: Inhelder and Piaget have studied the differences between the problem-solving activities of the early adolescent in contrast to those of the child a few years younger. In general, the older child seems more able to consider hypothetical possibilities and their systematic analyses. Wallach concludes that "the younger child's major cognitive attainments concern his increasing skill in dealing with external events and objects-maintaining the constancy of their properties across irrelevant changes, classifying them, seriating them. The older child, obviously with the aid of his increasing linguistic competence, proceeds to describe the results of these dealings in propositions and then to relate the propositions in various ways." He sees three possible explanations for this change in problem-solving abilities: (1) language; (2) societal pressure to deal with the world unassisted by elders; (3) overlearning in the skills involved in dealing with concrete objects and events. In a concluding section, Wallach asserts that the evidence reviewed in this paper suggests that structural changes in the nature of adaptation to the environment occur in the course of development, with one major transition taking place between about 5 and 8 years; i.e., "the age period during which conservation of many properties across irrelevant changes, classification skills, and seriation abilities all have been found to develop." He also includes a brief review of psychometric work on intelligence tests where developmental change or constancy was studied.

4.5.1.18 Williams, A. Mathematical concepts, skills, and abilities of kindergarten entrants. Arithmetic Teacher, 1965, 12, 261-265.

Hypotheses: In order to gear math curriculum to preschool children, the experimenter attempts to ascertain their level of math readiness at the time of school entry. The experimenter presents four aims: (1) To ascertain the nature and extent of math achievement of pupils entering kindergarten. (2) To discover levels of achievement of various groups when categorized by selected psychological and sociological factors. (3) To ascertain the relationship between math achievement and these various psychological and socioeconomic factors. (4) To discover by the correlation method some of the home circumstances and conditions which produce high math achievement.
Method: A random sample of 595 kindergarten entrants (mean IQ of 103.7) drawn from six elementary school districts from the Los Angeles area was given the Pre-School-Kindergarten Modern Mat Test during the first four weeks of school. This test measured (1 numbers and operations; (2) geometry; (3) measurement; (4) functions and graphs; (5) mathematical sentences; (6) logic; (7) sets; (8) mathematical problem solving and applications. Reliability of the test as measured by the Kuder-Richardson-Formula 21 was .90. The experimenter did not indicate the scale used to distinguish classes. Home conditions revealed by such factors as child's knowledge of TV channel numbers, ability to recite home address and telephone number, and time spent playing cards and number games were ascertained by questionnaires.
Results: Using an "analysis of relationship:" (1) Correlation between Math scores and mental age = .70 (.01 level) (2) Correlation between Math scores and IQ = .75 (.01 level) (3) Correlation between Math scores and chronological age = not significant (4) Correlation between Math scores and socioeconomic status = .26 (.0001) (5) Of the 17 selected home circumstances, the two closest relationships were that of math scores and knowledge of TV channel ($X^2 = .38$, $p < .001$) and frequency of playing counting games ($X^2 = .38$, $p < .001$).

4.5.3 MEASUREMENT AND TECHNIQUES

4.5.3.1 Rappoport, L. Detecting a cognitive schema in a young child. Psychology Reports, 1964, 14, 515-518.

This case study discussed the detection of cognitive schemata in preverbal children when only minimal background material is available. The usefulness of a controlled observational approach is compared with a naturalistic observational approach. The particular questions is that of the achievement of an effective drawing-pulling schema in a boy, 1 year, 3 months, over a three day span. In a simple test situation (controlled observational approach), subject can only achieve a goal (i.e., a sugared puff used as a reward) by means of the drawing-pulling activity of retrieving a matchbox containing the reward from a tabletop by pulling the attached 2-foot string. In the third and fourth of four trials on day 1, a book is used to block the initial sight on the matchbox. Subject follows the emerging box with his eyes as he pulls the string, suggesting that he has acquired the schema, but this schema is only used with prompting, when other schemata are prohibited (i.e., he cannot climb onto the table to get the reward). The author expresses two reservations about this method, which are enhanced by the child's irritation with the problem on the following day: (1) the stringbox is novel and may interfere with the task; (2) a food reward could result in the initial affect arousal being too high and subsequent satiation being too rapid. The second situation is more naturalistic and phenomenological, developing (on the third day) as part of a play behavior sequence and giving more useful or convincing evidence that the child has achieved the schema. A cart for blocks, with a 3-foot string attached, is usually carried rather than drawn by subject. The experimenter puts blocks in the cart and calls to the subject to see the experimenter pull it. The experimenter gives the subject the string and tells him to find mama. Subject goes, looking back at the moving object. The crucial test occurs when the cart's sticking on the threshold has yanked the string out of the child's hand. At this point the previous schema of carrying opposes the schema under study; subject picks up the string and pulls until the cart is over the threshold.

4.5.4 INTERVENTION

4.5.4.1 Feigenbaum, K.D., and Sulkin, H. Piaget's problem of conservation of discontinuous quantities: a teaching experience. Journal of Genetic Psychology, 1964, 105, 91-97.

Problem: As used by Piaget, the principle of conservation of quantity involves separation of the number aspect of an aggregate from the spatial arrangement of the items in the aggregate. For Piaget, the knowledge of conservation is a prerequisite for the understanding of concepts of number, and depends on the acquisition of the principle of one-to-one correspondence. The purposes of this study were (a) to test and compare the efficacy of different methods of teaching the principle of conservation and correspondence to children; (b) to interpret the results of these methods in order to provide further explanation of the child's acquisition of the conservation concept. The first method derives from Wohlwill's finding that experience with addition and subtraction is more effective than other methods in inducing conservation. The second method derives from a current idea in concept formation that reduction of irrelevant stimuli decreases task difficulty.

Method: Subjects were 50 kindergarten children, racially and economically heterogeneous. The apparatus used were large beads of like color, 3/4 inch blocks of another color, three bottles, (two of the same size and one smaller). A pretest was given to eliminate those subjects who had already acquired the concept of conservation, and the remaining subjects were placed randomly in three treatment groups. The treatments were: (1) Reduction of irrelevant stimuli--subject was blindfolded and told to drop beads, by pairs, into two large glasses. Subject was then told to pour contents of one bottle into smaller one. These operations were performed to test for transfer without blindfold and using wooden blocks. (2) Reinforcement by addition and subtraction--experimenter added one bead to a pile of beads and subject asked whether number of beads had changed. If subject did not say yes, the correct answer was explained to him. (3) Combination of 1 and 2--any subject failing treatment 1 was administered treatment 2.

Results: A significant difference between treatment groups at the .01 level ($X^2 = 9.55$) was found. With first treatment, 14 subjects gained an understanding of the conservation principle, and only three subjects in the second treatment group learned the principle. Of the 16 who failed the first treatment and were given the second treatment, none understood the principle afterwards. Retention of the concept after 1 week proved successful for both methods.

4.5.4.2 Ojemann, R. H., and Pritchett, K. Piaget and the role of guided experiences in human development. Perceptual and Motor Skills, 1963, 17, 927-940.

This paper discusses planned learning experiences in relation to Piaget's analysis of stages and their order in children's cognitive development, and then presents an experiment for assisting the development of the concept of "specific gravity." "Guided" or "planned learning experiences" are defined as attempts to promote an individual's learning a specific thing by means of a planned sequence of experiences of progressive mastery, derived from analysis of the nature of the task and of the learner, and by motivating the individual to participate in the experience. Piaget is critized for ignoring the antecedent conditions and environmental variations in development and for not taking into account the effect of interventions and of possible development in a direction opposite that of the expected sequences in development. The hypothesis tested was that "planned learning experiences can alter the course of development of the concept" (e.g., of specific gravity). This involved the development of a program of instruction and evaluation aimed at helping the child to abstract the concept from his experiences. To understand "why does this thing float (or sink)?" requires the ideas of the weight of an object and the weight of an equal amount of water. Various stimuli (verbal, visual, etc.) were used to help the child make the abstraction. The program took place in three 1-hour sessions. Initially, there was a discussion of why the group should spend time figuring out why things float and consideration of the children's reasons in turn: demonstrations of the ideas of lighter-heavier on balance scales using different objects. The second hour included demonstrations of the displacement of water and the reasons two things cannot simultaneously occupy the same space. The third hour related more directly the way the weight of the displaced water works in the problem and included eight exercises in demonstration form; e.g., which of two different sized objects displaces more water? of two same sized objects? For an object that floats, will the object or the displaced water weigh more?

Subjects were 18 kindergarten children and 21 first graders, half of each in the experimental and the control groups. Pretests and posttests were given individually. These tests were the O-P (Ojemann-Pritchett) and Piaget tests, which were similar, except that the latter used different materials from those used in the planned learning experiences. The O-P test was administered 3 or 4 days prior to instruction, and that and the Piaget tests were given 1 or 2 days following the instruction. The control group received no instruction. Results were interpreted in terms of general stages necessary for an understanding of the concept of specific gravity. In neither age group were there significant preinstruction differences in IQ or pretest scores. The experimental kindergarten group showed a significant gain over controls in the posttests, and since the Piaget test involved new materials this is some evidence for generalization in the learning. Two types of analysis of this data showed the gain to be significant at or better than the $p < .02$ level, and in individual O-P scores, six of the nine experimental kindergarten children exceeded Piaget's suggested age for the attainment of the concept. There was some question if the children who gained 2 or 3 stages actually went through these levels of thinking of if they jumped the intervening steps. The first grade experimental group showed significant gain on the O-P scores ($p < .05$) and were just short of this on the Piaget posttest. Most of the children in this group were already at the third of four levels used in measuring the degree of understanding of the concept. The authors conclude with an emphasis upon the importance of specifying the nature of the child's experiences, and questioning whether Piaget's hierarchy of stages is a necessary and inevitable one. They suggest that more effective experiences may be planned and implemented to augment learning.

4.5.4.3. Smedslund, J. The effect of observation on children's representation of a water surface. Journal of Genetic Psychology, 1963, 102, 195-201.

This study reports more systematically and objectively upon a phenomenon described by Piaget and Inhelder in The Child's Conception of Space related to children's representation of horizontality. Previous evidence seemed to strongly suggest that up to 7 or 8 years, children do not possess the concept of invariant horizontality of water surface, and that children lacking this concept do not seem to profit from observation. According to Piaget and Inhelder there would be no direct feedback from the external world but the feedback is always determined by the way in which the subjects assimulate the situations. Only the progressive development of spatial concepts give rise to the beginnings of a schema for horizontality which can then be empirically confirmed by subjects. The procedure followed with the 27 subjects (5- to 7-year-olds in a nursery in Oslo) involved the following steps: (1) Subjects were shown a picture of a bottle half filled with water and asked to notice the position of the water in the bottle; (2) Six pictures of bottles tilted in various directions were presented one at a time to the individual subjects, who were instructed to draw the water surface as it would appear in each; (3) A flat bottle, half-filled with ink-water was presented and tilted in steps of 30 degrees throughout 360 degrees; (4) The same as step 2; i.e., presentation of six bottle-pictures on which subjects were to indicate the appropriate water surfaces; (5) Three sets of 8, 7, and 8 models pictures were presented to each subject who was to indicate the one correct drawing in each series. Two judges independently socred (1) The change from pretest to posttest drawing of water level by the subjects as "better," "unchanged," or "worse." The initial agreement on the 162 pairs of pictures compared was 84 percent. (2) The judges' agreement on a comparison of the posttest drawings and the choice of model pictures, as giving two measures for whether the child possessed the schema or not, was initially 83 percent on the 81 comparisons. In both cases, the discrepancies were discussed and a final unanimous agreement reached. The total number of subjects with no correct drawings and with all drawings correct remained the same. "Nearly all" subjects who had no correct drawings in the pretest failed to profit from the observation opportunity, but there was some improvement in "nearly all" who showed some initial traces of horizontality.

4.5.4.4 Wohlwill, J.F., and Lowe, R.C. Experimental analysis of the development of the conservation of number. Child Development, 1962, 33, 153-167.

Problem: According to Piaget, the lack of the principle of conservation (invariance of number under changes in length or configuration of a collection) represents a manifestation of the immature level of functioning of the child's mental processes and of their failure to conform to the operational structures of logical thought. Little is known about the ways in which this lack of transition to its presence takes place. Wohlwill offers three interpretations of the acquisition of this principle, with respect to the domain of number: (1) The reinforcement hypothesis: the child gradually learns that alterations in the perceptual dimensions of a set do not change its number. Reinforced practice in counting rows of elements prior and subsequent to changes in the length of the rows should promote conservation. (2) Differentiation hypothesis: lack of conservation as a response to an irrelevant but highly visible cue (length). Child must learn to differentiate the dimension of number from the irrelevant cues. Repeated experience, designed to neutralize the cue of length, should promote conservation. (3) The inference hypothesis: through observing the effects of adding or subtracting an element to or from a collection, the child may be led to infer conservation as the result of a change involving neither addition nor subtraction. The main aim of this study was to bring to bear each of these theoretical interpretations in a learning experiment, determining the effectiveness of the various conditions of learning in bringing about conservation, both in a limited and generalized sense.
Method: The subjects were 72 kindergarten children, 35 boys, 37 girls, mean age of 5 years 10 months. This age level was selected because most children still show lack of number conservation but are old enough to profit by the learning experience. There were 18 subjects in each learning condition. The design contained the following parts: (a) A verbal pretest to test the subject's ability to deal with number concepts and conservation. (b) A "nonverbal" test of conservation, in the form of a series of multiple-choice trials. (c) A training series on tasks presumably related to conservation. (d) A repetition of the conservation tests to provide a measure of learning. There were four conditions of training: Reinforced Practice (RP), Addition and Subtraction (A & S), Dissociation (Diss) and Control. The three conditions related respectively to the reinforcement, inference and differentiation hypotheses described above.
Results: The results of both verbal pretest learning of nonverbal conservation, and the transfer of training to the verbal posttest are all reported. Since the results of the verbal pretest cannot be adequately summarized, only the second and third groups of results will be summarized here. Nonverbal conservation learning:

Analysis of variance revealed no significant differences among training groups with respect to learning of nonverbal conservation. But the mean overall difference scores differed significantly from o ($t=3.95$, $p<.01$) showing that for the group as a whole, conservation did increase from pretest to posttest. Transfer of training to the verbal posttest: There were few changes in any group, in verbal conservation.

Discussion: Wohlwill comments on the fact that although a significant amount of improvement from pretest to posttest did take place for the group as a whole, there was a lack of significant differential effects of conditions of training and, also, that the control group gained more than either the Reinforced Practice of Dissociation groups. He questions whether a more extended series of training trials might yield a greater amount of learning (there were only 18 training trials in each of the experimental conditions in this study). The greatest improvement took place in the A & S group, this being consistent with the possible role of a process of inference (i.e., conservation as the end-product of changes involving neither addition nor subtraction, to which a previous study of Wohlwill had pointed (Journal of Genetic Psychology, 1960, Volume 97).

Also, none of the above procedures proved effective in leading to an understanding of the *principle* of number conservation, as demanded by the verbal posttest. Wohlwill attempts to explain this failure to transfer by suggesting that the child had developed, in the nonverbal situation, an *empirical rule* for making the correct response, rather than a *logical principle*. Wohlwill also raises some interesting questions about the use of nonverbal methods in the investigation of children's thinking, and their effectiveness as training procedures. He stresses the point that one must therefore use transfer tests, when using nonverbal methods, to determine the breadth and depth of the child's understanding of the principles or concepts in question.

In conclusion, although, Wohlwill states, no definite answer was obtained about the mechanisms involved in the acquisition of the conservation of number, a few interesting points are made by him: (1) The behavior of the subjects lends some weight to the interpretation of lack of conservation as a failure to differentiate *number* from irrelevant perceptual cues. (2) Since children typically receive much experience in addition and subtraction during the time period in which conservation usually appears (late kindergarten, early first grade) this suggests that the process of inference may be operating in this development. (3) This study shows a gap between the ability to *enumerate* collections by counting and a true understanding of the number concept.

4.6
PERCEPTION AND RECOGNITION

4.6.1 NORMATIVE

4.6.1.1 Corah, N. The influence of some stimulus characteristics on color and form perception in nursery school children. Child Development, 1966, 37, 205-211.

Purpose: To study the interaction between the stimulus characteristics of amount of color, complexity of shape and number of color-dominated responses in preschool subjects.
Subjects: 126 boys, 84 girls 3:2 to 5:8 years old; mean age is 4 1/2 years; 72 boys, 72 girls 7:1 to 9:11 years old; mean age is 8:9 years.
Procedures: Three sets of pictures, each set containing nine plates, and organized by a specific principle are shown to subjects: Set 1--Each plate contains a standard object and two comparisons; e.g., red square is standard, red circle and blue square are comparisons. Set 2--Same as set 1 except that the comparison figure was shaped very similarly to the standard; e.g., red square, red rectangle, blue square. Set 3--Standard shapes were asymmetrical forms with 5 to 7 sides; the comparison of the same color was a different asymmetric shape. In each set, half the colored forms were solidly colored (SC) and half were only outlined in color (OC). Because this would make set 3 especially hard, another set was designed with the same shapes as set 3 but the comparisons on any given plate were the same color as the standard so the subject was forced to make a form discrimination. Each plate was shown twice to each subject and the comparisons were randomly arranged on each side of the standard, all three on an llx8 1/2-inch paper.
Design: Preschool subjects were randomly assigned to the seven stimulus groups with an equal number of boys and girls in each. Each subject saw only the plates in the subgroup to which he was assigned. Subjects who gave six or more consecutive responses to one side or had fewer than five answers following any principle (consistancy score) were replaced by new subjects; there were 89 such cases. Older subjects were assigned only to sets 1, 2, and 3. Mann-Whitney U tests were used to test the significance between older and younger subjects and to make individual comparisons between the groups for each age level. A Kruskal-Wallis one-way analysis of variance was also carried out on the preschool groups. Chi-square was used to test the significance of the number of students excluded.
Findings: 1. Preschool subjects gave significantly more color responses to every stimulus set, significant levels were $p < .05$

for one group and $p < .0001$ for five sets. 2. A one-way analysis of variance for the six preschool groups yielded an H significance at $p < .001$. In two of the three comparisons between the preschoolers' response to OC and SC the results were significant ($p < .05$) and 2($p < .01$) with more color choices being made to SC stimuli. The third comparison was not significant except in the predicted direction. 3. The differences in responses among stimulus complexity sets within SC and OC groupings are all in the predicted direction with some being significant at better than $p < .05$. Significantly more color responses are made to I-SC than 3-SC, to 2-SC than 3-SC, to I-OC than 2-OC, and to I-OC than 3-OC.
Conclusions: 1. Results support hypotheses that the amount of color and complexity of stimulus is significantly related to number of color responses made by preschool subjects and is responsible for the distribution of exclusions. 2. Significant developmental differences indicate that younger subjects make more color responses under all stimulus conditions, but in five of the six cases the majority of the responses were form-dominated. 3. Comparing these results with earlier studies (Doehring, 1960; Kagan and Lemkin, 1961) indicates that subjects are no longer responding in terms of color as frequently as they did in the past. This may reflect the increased use of geometric forms in children's toys which means that such forms when presented as stimuli are no longer meaningless to subjects and supports the hypothesis that subjects are less attentive to the contours of a strange object when a dimension which is more familiar (color) is also present. 4. The fact that some studies find older children and adults responding on the basis of color probably reflects a perceptual style of preference (Gaines, 1964).

4.6.1.2 Freedman, D.G. Smiling in blind infants and the issue of innate versus acquired. Journal of Psychology and Psychiatry, 1964, 5, 171-184.

This article deals with the "innateness" of the baby's smile and provides some clarification of the problem through data from studies of blind infants. The literature supplies the following observations from which the author draws some of his conclusions, and in conjunction with his own observations, and from his own ongoing research, discussions with others involved with the type of disabled infants involved. Since blind, deaf, and blind-deaf children smile, no single sensory channel can be the exclusive releaser. Vision may be said to facilitate smiling since blind children do not show normal, prolonged smiling until 5 or 6 months. Age seems to be important in the development of smiling. Different environments tend to slow or speed its development, depending upon the social stimulation provided. Deferred imitation (i.e., imitation occurring at a different and later time from the imitated behavior) does not appear until after 1 year and, therefore, smiling is not initially imitative. During the first year, smiles are increasingly reserved for familiar people. In the first weeks of life smiles are nonelicited, although usually fleeting. By the end of the first month, smiling may be elicited by touching parts of the infant's face and the sound of the human voice. Most of the current data agree with L'Allier's study (1961), that the visualized moving face is the most efficient stimulus for smiling at this age and secondly, the human voice. Most of the interest and work has been in the area of smiling to a visual stimulus: Kaila's "der menschlichen Augenpartie" or the Gestalt of the en face eyes; Spitz and Wolf added the element of movement as important, and having its clearest positive effect between 2 and 4 months; Ahrens showed that with increasing age greater detail was necessary to elicit the response, beginning with the top half of the facial features. Ethological comparisons have been made; e.g., the "gapping" response to a "super-normal sign stimulus" in the thrush and herring-gull, with the baby's response to the exaggerated eye-part of the face.

Few studies have studied smiling in congenitally blind infants. The standard and accepted definition of blindness is that the correct vision in the best eye is less than 20/200. Thompson quantified various aspects of facial movements in blind and sighted children and found a decrease in the amount of facial movements after 6 years of age in the congenitally blind. She hypothesized the necessity of imitation in order to stylize expression. Various other reports, with small samples indicate that, when corrected for premature birth dates, smiling occurred in blind babies at approximately the same time as in sighted siblings. No negative evidence is available, so it seems that vision is not a prerequisite for social smiling.

In the author's own ongoing study, the first elicited smiles have been observed within 2 weeks of onset, in four congenitally blind infants, all with bilateral blindness. These children tend to stare at a bright light but do not follow a light or object. The observations were initiated between 2 and 4 months of age in these babies. Bayley's Infant Mental and Motor Scales indicated that aside from visions, they were within normal limits of development. The first smiling seemed to be fleeting, and by 6 months appeared as prolonged social smiling. Two interim hypotheses were proposed: "(1) The initial elicited smiles were reflexive in nature, since there was the typical sharp onset and almost immediate waning. (2) In these early months prolonged social smiling seems to require visual ragard as a maintaining stimulus." Additional case material from the most closely observed case is presented, in which temporary "hands-before-the-face" behavior appeared and dropped out (a suggestive basis for innate elements in hand-eye coordination?). No careful studies of infants with other abnormalities are available with regard to the development of smiling. A generalization from observations and discussions suggests that (in deaf-blind, deaf, and impaired defectives) smiling tends to remain intact despite substantial biological impairment. After considering the arguments presented by nativistic and learning positions Freedman concludes that neither has helped much to clarify the mechanisms behind smiling in human babies; however, much of the evidence at present indicated an innate basis: lack of ability for deferred imitation, reflexive nature of early social-smiling in blind infants, the twitching-myoclonic pattern of early nonelicited smiling, inability to demonstrate either tension-reduction or conditioning as the cause of early smiling, etc., the universalistic nature of smiling across cultures and among otherwise defective individuals, and, finally, strong suggestions of evolutionary functions (e.g., as a signal of mutual positive feeling). Freedman's final comment is that whether smiles are inherent or induced, the relationship of this behavior to the rest of behavior and life of the individual should be explored.

4.6.1.3 Kerpelman, L.C., and Pollak, R.H. Developmental changes in the location of form discrimination cues. Perceptual and Motor Skills, 1964, 19, 375-382.

The two experiments reported here dealt with the analysis of cues used in discriminating forms. Experiment 1 was a pilot experiment undertaken to find 3 or 4 geometric forms which would all be equally discriminable within each of three age groups. Subjects were 30 nursery school children: ten 4 years, twelve 5 years, eight 6 years. Subjects were tested individually on matching five irregular pentagons with their duplicates, given one pair and four other pentagons on each trial. Simpler forms were used for familiarization with the procedure, and in the 30 test trials, each subject received six exposures of the five pentagon pairs. There was no material reinforcement. The results showed a consistent but insignificant, distinct drop in discrimination performance between the 5- and 6-year-olds on four of five stimuli, and this unexpected finding motivated the second experiment. The stimuli from experiment 1 were compared on seven dimensions, and each was compared with the other stimuli with which it had most and least often been confused. Discrimination by the 4- and 5-year-olds appeared to be according to differences in the bottoms of the stimuli, and 6-year-olds used a combination of the top attributes, vertical extent, and bottom attributes. This suggested the possibility of a shift to a top-to-bottom scanning mechanism, which, if valid, would support the expectation that discrimination ability would again increase after the transition to the new scanning mode. In experiment 2, 80 subjects of 4, 5, 6, and 7 years received a task similar to those in experiment 1 and were randomly assigned to one of the following four subgroups which designate the type of form discriminated:

whole pentagons (W); five bottom stimuli, the three bottom vertices being attached to uniform rectangular areas so that only the bottoms of the figures differed (B); five top stimuli, halved in similar manner to B (T); center strips, formed by vertical, parallel lines equidistant from the bottom vertex of the whole pentagon (C).

Results: A two-way ANOVA on the W forms produced a significant age effect ($p < .025$) and replications effect ($p < .05$). The results of experiment 1 were not replicated since there was a rise in performance between the 5- and 6-year-olds. An analysis of the component forms provided some information on the developmental course of the perceptual process. On the combined part-forms, there were significant effects of age ($p < .001$), forms ($p < .001$) and age by forms ($p < .05$). By age group there were significant age effects at 4 years ($p < .01$), 5 years ($p < .005$) and 7 years ($p < .025$). Further investigation showed that these results were mainly due to poor discrimination of C forms at ages 4 and 5; at age 7 this was due to significantly poorer discrimination of T forms. Trend analysis showed a significant increase in linear trend for B and C forms (both at $p < .001$).

Discussion: Although the results of experiment 1 were not replicated, the general hypothesis about the perceptual scanning mechanism in children was supported. B forms were most easily discriminated by all age groups, and increasingly so with age. Discrimination of C forms showed a steep linear increase from 4 to 7 years, which at 7 years almost equaled that of W forms. The supported finding that younger children tend to use bottoms of pentagonal stimuli as discrimination cues, and with age employ a top-to-bottom scanning is similar to findings by Ghent. There may be interaction with other dimensions not considered here. The authors conclude with two suggestions: Perhaps developmental parameters should be included in informational analyses of form discrimination performance. And more work needs to be done with different subjects and forms, since the results here are based upon assumptions that part-forms, designed to get at top-to-bottom discrimination of specific forms, actually tap the particular hypothesized perceptual process.

4.6.1.4 Reese, H. W. "Perceptual set" in young children. *Child Development*, 1963, 34, 151-159.

The theoretical background of this study involves the changes in the interpretation of ambiguous figures when they are presented in a series of unambiguous figures which have common conceptual properties. This mediational interpretation of the effect of "set" is derived from four assumptions: 1. on set-inducing trials, the concept is conditioned to some "ready signal"; 2. the concept produces stimulation which has the tendency to elicit other verbal responses, and therefore eliciting one concept increases the chances of the production of related associations; 3. an ambiguous figure (by definition) tends to elicit two or more verbal responses designating objects of different conceptual classes; 4. if the response to the ambiguous figure is also to a concept or elicits a concept, these responses (habits) summate, and if the resulting habit or tendency to respond is dominant, the response occurs in line with the concept elicited. The particular question in this study starts with a hypothesized deficiency in mediation in children and predicts that a series of unambiguous figures will determine the responses of older children to an ambiguous figure but that this series will have no effect on the responses of younger children to the ambiguous figure; i. e., mediational processes, such as an induced "set" for a certain concept, are developmental and are more apt to be observed in older subjects than in young subjects.

Subjects were 49 young preschoolers (median age 46. 1 months), 53 older preschoolers (median age 58. 2 months), 89 kindergarteners (median age 72. 2 months), 102 first graders (median age 83. 7 months), and 85 second graders (median age, 95. 0 months). Line drawings on individual cards were presented to the subjects. The ambiguous figure is generally seen as either a rat or a human face. A third of each age group was presented with one of three series of seven pictures: the last of which was the ambiguous rat-man; series H, human faces and heads; series A, animals; series C, other objects. At the end of each presentation to a subject, an attempt was made to assess the possession of class concepts by asking the child to sort all the drawings. To determine the strength of the set effect, a comparison was made of the pattern of response in the experimental groups with the control group at each age level, and doubtful responses were not included in the analysis.

The age trend in the strength of the set effect was assessed by comparing the patterns of response of two age levels in each experimental group. For the H (human series) group, the proportion of responses consistent with the human set was significantly greater at the second grade level than at the young preschool level ($X^2=4.10$, $p<.05$), for the A (animal series) group on these two age levels ($X2=6.04$, $p<.02$). The second grade versus the combined preschool groups in the H series was $X^2=4.68$, $p<.05$, but the age difference was not significant for the animal series group scores. The difference between the human and control (C series) groups was significant from kindergarten up. The differences between the animal and human series group scores were highly significant ($p<.001$) at every age level except the youngest. The tendency to give responses consistent with the animal set were stronger than the tendencies to be consistent with the human set. The animal set effect, but not the human set effect, was significant at the older preschool level, suggesting that the animal set was easier to establish.

Reese also pointed out that the greater variability in the human set responses might mean that the children were responding to more different concepts; e.g., head, face, etc. The prediction was confirmed and the hypothesis supported in that the set effect was stronger at the older age levels than at the younger and not significant at the youngest. Reese suggested that the mediational deficiency might be a function of age or of the early stages of concept formation.

4.6.1.5 Spears, W.C. Assessment of visual preference and discrimination in the 4 month old infant. *Journal of Comparative and Physiological Psychology*, 1964, 57, 381-386.

This study was undertaken to confirm and expand certain findings about the visual capacity of human infants, using visual fixation time as an "indicator response." There is some disagreement about the relative preference for colors at various age levels, but there is evidence to suggest that some ability to discriminate colors is present at 4 or 5 months of age. For the author, a clearly established preference indicates discrimination capacity. The method of paired comparisons was used as the simplest approach to ranking a number of stimuli, and presuming that this would permit the determination of certain preferences, in order to then assess the relative effect of shape or color. Shape was quantified by contour, number of turns or symmetry, and color according to Munsell coordinates.

Subjects were in their fourth month. The design of the project was as follows:

Group	Number	Age (in days)		Subjects completing session		Number of subjects tested to obtain 10
		median	range	boys	girls	
Shape 1	10	116.5	112-158	3	7	16
Shape 2	10	123.5	111-135	4	6	13
Shape 3	10	116.0	109-138	6	4	15
Color	10	124.0	117-153	3	7	11
Shape-Color 1	10	135.5	111-144	6	4	15
Shape-Color 2	10	116.5	112-126	5	5	16

The first three groups were run concurrently; and the last three groups, separately and consecutively. Apparatus included a cubic box with flat back interior within which the stimulus cards were presented, side by side, A slot between the cards provided the view whereby the experimenter observed the infant, who was held in a seated position by the mother about 10 or 14 inches from the stimulus.

Two standard electric clocks recorded accumulated visual fixation time to the right and left stimuli separately, via a toggle switch operated by the experimenter. The toggle switch was also connected to a counter, whereby the number of eye movements were recorded. The stimulus cards (22 square inches) were divided equally between white and colored figures, except card X which was completely red. The groups were named according to the stimuli configurations:
Shape 1--diagonal pattern, bull's-eye, checkerboard, random pattern.
Shape 2-- " " " " card X, random pattern.
Shape 3-- " " " " checkerboard, card X.
Color--4 bull's-eyes in red, yellow, blue and gray (with white background).
Shape-Color 1--diagonal and bull's-eye, each in red and in gray.
Shape-Color 2--hexagonal and bull's-eye figures, each in yellow and in blue. These were designated by RBU for red bull's-eye, GDi for Gray diagonal, etc.

Twelve 15-second trials were run with 30 seconds between trials. Even numbered subjects received one random order, while odd numbered subjects received the reverse sequence. Counterbalancing of stimuli for each subject (each pair of cards was presented twice to subject in opposite positions) made any position-bias obvious. Trials were discontinued when lack of "interest" or degree of crying precluded clear observation of eye movement. Basic orderings and significant differences are presented below. Individual consistency of each subject was computed (Kendall Test) on the basis of the presence or absence of circular triads. The main concern is with the group trends as shown by coefficients of agreement for each group. All groups but shape-color 2 were significant, the color group at the $p < .01$ level and the remaining groups at the $p < .001$ level.

Group	Orderings	Significant Difference (1st indicated stimulus preferred 9 out of 10 times)
Shape 1	Bu>Ch>Ra>Di	Bu>Di, Ra>Di
Shape 2	Ra>Bu>X>Di	Bu>Di, Bu>X, Ra>Di
Shape 3	Bu>Ch>Di = X	Bu>Di, Bu>X
Color	BBu>RBu>YBu>GBu	BBu>GBu
Shape-Color 1	RBu>GBu>RDi>GDi	All pairs perfect transitivity
Shape-Color 2	YHex>BBu>BHex>yBu	No pairs

In the shape groups, the bull's-eye was preferred over the diagonal pattern and the solid red card. (All of the cards used for shape were the same color on a white background.) The random pattern was preferred to the diagonal. The transitivity of preference demonstrated for these stimuli was that shape precedes color as a dominating dimension (for this age). The "red-gray" preference holds within the division set by shape. Red and Blue were significantly preferred to gray; the bull's-eye pattern, to other patterns. The shape-color 1 group demonstrates shape as the dominating dimension for preference, and red was significantly preferred to gray. For the second shape-color group, where there was no preferential ordering, there may also be the question of whether the bull's-eye was discriminated from the hexagon.

4.6.2 ENVIRONMENTAL

4.6.2.1 Antonsvsky, H. F., and Ghent, L. Cross-cultural consistency of children's preferences for the orientation of figures. American Journal of Psychology, 1964, 77, 295-297.

This study provides cross-cultural comparison data on children's orientation of geometric figures, in the form of a stable judgment of right-side-upness, for a particular analysis of their responses indicate that a figure is judged to be "right-side up" when the focal point is located in the upper half of the figure. Subjects were 20 girls and 20 boys of the upper class, 4 and 5 years old, in a nursery school in Teheran, Iran. The stimuli were a series of 33 cards, 10 with pairs of realistic forms (useful in determining if the subjects understood the directions), 13 with pairs of simple geometric shapes (test set), and 10 with more complex pairs (originally used to determine the effect of size, brightness, and color).
Results: Responses of the Iranian children were in the same direction as those of American children. Their choices were consistently different from a chance selection ($p < .05$) for 11 cards and at $p < .06$ confidence level for the remaining two cards of the test set. These last two cards also evoked the lowest consistency of response in American children. American and Iranian children both showed a strong preference for vertical orientation. Iranian children were somewhat less consistent in all their responses which may have been due to their younger age (than American subjects) or to the presence of a foreign investigator. The results are consistent with the notion that such preferences are related to the basic processes of form-perception.

4.6.3 MEASUREMENT AND TECHNIQUES

4.6.3.1 Santa Barbara, J. F., Jr., and Pare, W. P. Information processing in preschool children. Psychonomic Science, 1965, 2, 143-144.

In some studies of the sensory ability to process information, the amount of information processed by various sensory modalities has been measured by "bits." The purpose of this investigation was to use this measure in determining the ability of preschool children to make identical-nonidentical judgments. A "bit" is the amount of information necessary to reduce uncertainty by one-half; i. e., a means of quantifying stimulus complexity, and this measure could be used to compare various sensory modalities in equivalent terms. Using this concept also involves the sometimes very ambiguous problem of which stimulus elements the subject pays attention to. The measure may be represented by $H-\log_2 n$, where H is the number of bits, and n is the number of units in the stimulus. Transformation of the stimulus complexity into bits was made from Attneave's table (1959). Twelve subjects were age 3; 15, age 4; and 12, age 5 years. Stimuli were 28 cards, each containing two figures, either identical or differing only in the number of prongs or projections of the figure. There were seven levels of complexity and only one card of the four at each level contained identical figures. Cards were presented singly, in ascending order of complexity, and subjects were to say if the figures were exactly the same. There was a brief pretest for procedural familiarization.

At level 1, the number of prongs in the nonidentical pairs were 5 and 7; number of bits, 2. 32 and 2. 81; number of prongs in the identical pair, 6; and for level 7, the same information: 11, 13; 3. 46, 3. 70, and 12, respectively. Levels at which respective age groups performed no better than chance were level 2 for 3-year-olds, level 3 for the 4-year-olds and levels 5 and 6 for the 5-year-olds. Main effects of age and of complexity were both significant ($p < .001$). None of the subjects reached the adult level of performance which had been determined in a separate test. The authors suggest the use of "bits" as the measure of perceptual abilities for other sensory modalities. They suggest that this measure could provide good operational definitions and be used to help determine the limits imposed on cognitive growth by perceptual development.

4.7
MOTIVATION

4.7.1 NORMATIVE

4.7.1.1 Clapp, W.F., and Eichorn, D. Some determinants of perceptual investigatory responses in children. Journal of Experimental Child Psychology, 1965, 371-388.

Purpose: The purpose of the study was to investigate the relation of different stimulus properties to investigatory behavior in human subjects.
Subjects: 12 boys and 12 girls, age 4 and 5 years old, enrolled in the nursery schools at the Harold E. Jones Child Study Center, Berkeley, California. None of the children had participated in any similar experiment.
Procedure: Subjects were shown 32 stimuli, each mounted on a separate 6 x 6 inch white paper, and presented in a Harvard tachistoscope for .14 second per trial. The stimuli were grouped in three units: (1) Incongruity = seven pictures of "a pattern with characteristics which subject has been trained to regard as incompatible"; such as two headed animal with only two legs. (2) Redundancy-geometric figures--10 cards arranged in three series cross in regular and irregular matrixes; a circle, a square, an octagon, and an irregularly closed curve; five straight lines, two straight lines, two straight lines and three wavy lines arranged assymetrically, and five lines of different sorts. "In each series the designs are listed in order of decreasing redundancy on the assumption that redundancy varies directly with orderly arrangement, with symmetry, and with similarity between parts of a figure and inversely with changes in contour." (3) Redundancy-meaningful objects = 15 cards with three modifications of each of five basic stimuli. "Type I cards were in color; type II cards were black and white stick drawings of the same objects. The five basic designs were "a rake and a spade, both brown and blue; an apple, rust with white spot; an overturned ink bottle and a blot of spilled ink, rust and black; two orange mushrooms and a few blades of green grass; and a horseshoe magnet and tacks, blue and brown and brown respectively." The presentation of all stimuli followed all permutations of a 3 x 3 Latin square with 2 boys and 2 girls assigned to each sequence. With each experiment, each presentation of stimuli, half the subjects of each sex were assigned randomly to one of two orders of presentation of stimuli. Subjects sat on a chair before the tachistoscope, which was on a table. The experimenter sat to the rear of the table, behind the machine and facing the subject. The subject was told he could see the picture as long

as he liked and when he wanted to see another one he should say "yes" or "another" and the experimenter would change the card. Each time the experimenter depressed the key, the card was visible for .14 seconds. Subjects were told not to tell the other subjects about the pictures and it is assumed they did not.
Results: (a) The mean number of responses per experiment is significantly different and the mean for the incongruity series much higher than that for the series of geometrical figures differing in redundancy. The mean response rate to meaningful objects is midway between the other two figures. (b) The colored pictures consistantly evoked a higher mean number of responses than the black and white pictures, the difference approaching significance. (c) The average response to the apple was greatest (6.17), followed by the rake and spade (6.1), the magnet (6), the ink bottle (5.4), and the mushroom (5). The mean for the ink and mushroom are significantly lower than the mean for the apple. (d) Overall, the sequence in which the experiments were presented did not affect performance. However, the order of presentation of stimuli in the incongruous group did affect response scores at a level approaching significance.
Conclusions: (a) Four and five year old children need at least .14 seconds to focus on material; otherwise their response rate reflects insufficient focusing time during the first showing. In an earlier study, Burgess (in Berlyne, D., 1957) gave children much less time exposure to similar stimuli and observed no reaction differences in subjects, but by giving subjects .14 seconds, the authors did discover differences. (b) Overall, there seems to be an unstable relationship between repeated exposure and mean responses made. Color, contour, and complexity of the stimulus influence the response pattern, but the exact relationship is unknown. Repeated exposure usually results in reduced response frequency between the first and second exposures but not always between the second and third. Successive reductions in response frequency are a function of the similarity between stimuli successively presented.

4.7.1.2 Crandall, V.J., Katkovsky, W., and Preston, A. Motivational and ability determinants of young children's intellectual achievement behaviors. Child Development, 1962, 33, 643-661.

Details: This study is part of a larger one, "Parents as identification models and reinforcers of children's achievement development" including four major areas of achievement: intelligence, physical skills, artistic-creative, and manual-mechanical. Two dependent variables (i.e., choice of participating in intellectual activities during free-play periods and intensity of striving exhibited in intellectual free-play activity) were assessed in an unstructured, free-play situation. Thirty-five of the 40 subjects attended a day camp at the institute for 1 week, in groups of 11 or 12. Except for lunch, there was no organized activity; however, there were miscellaneous play materials and equipment conducive to achievement activities in all of the four areas mentioned above. Examples of the intellectual materials were books on science topics, checkers, chess and other competitive games, jig-saw puzzles, form boards, math and reading flash cards, and other games which could be used individually or in groups. There were two full-time observers who were randomly assigned to do time-sample observations for each child. Three -1minute observations per child per day totaled to 15 observations per child. Both observers watched the same child for the same period and rated the behavior independently immediately afterwards. (A) Amount of time spent in intellectual activity, actual time during all 15 observation periods on a 0-4 rating. : 0--no intellectual involvement; 1--10 seconds or less, but some intellectual activity; 2--10 seconds to 30 seconds involvement; 3--more than 30 seconds but less than the full minute; 4--full period of involvement in intellectual activity (B) Intensity of striving, quality, degree of concentration, but not necessarily amount of success, a 1-4 rating when (1) was at least a 1 rating: 1--minimum concentration and effort, "playing around"; 2--concentrating briefly (10 seconds or less), easily distracted or only moderately striving; 3--intense involvement for 10-30 seconds, or moderate concentration for more than 30 seconds; 4--intense, strong striving and concentration, employing observable personal achievement standards to his efforts

Correlation of A and B was .61. Interrater reliability for the first two camp groups observed 0.98 for A and 0.90 for B. Ratings were thought to be simple, objective, having overt behavioral referents.

Further references:
Crandall, V.J., Katkosky, W., and Preston, A. A conceptual formulation of some research on children's achievement development. Child Development, 1960, 31, 787-797.
Crandall, V.J., Katkosky, W., and Preston, A. Parent behavior and children's achievement development. Genetic Psychology Monographs (in press in 1962).

4.7.1.3 Pielstick, N.L., and Woodruff, A.B. Exploratory behavior and curiosity in two age and ability groups of children. Psychology Reports, 1964, 14 (3), 831-838.

The purpose of this study was to determine the effects of age and ability on exploratory behavior (i.e., "any behavior that indicates interest in, or particular attention to one portion, as opposed to the rest, of the surround..") of children in two situations: (1) a semistructured observational situation; (2) when using subject-controlled tachistoscopically presented stimulus materials. The second condition was used to determine the effects of stimulus complexity on curiosity arousal, where curiosity is defined as a motivating factor for exploratory behavior in the absence of strong specific needs. Subjects were 64 second and sixth grade children of six randomly selected schools of DeKalb County, Illinois. The independent variable of grade was treated as roughly equivalent to chronological age (CA). The age divisions were 7. 6 to 8. 7 (mean CA = 8. 4) and 11. 3 to 12. 11 (mean CA = 11. 11), and 16 subjects of each age group had (Binet) IQ's of 132 and above. Subjects were tested individually in a mobile lab, which contained an observation room and one-way window(mirror) to the experimental room. Condition 1, above, semi-structured observational, involved leaving subject alone in the room for 7 minutes, with instructions to spend his time with the following objects until the experimenter returned: (1) kaleidoscope, (2) cigar box with four wire puzzles, (3) partially assembled 500-piece jig saw puzzle, (4) children's book in Russian, (5) "novel object" 10 inches high, brown and yellow, triangular, (6) one-way mirror. These objects represent three classes of exploratory behavior deriving from perceptual (5), (6), and epistemic (3), behavior (4), and manipulatory drive (1), (2). In condition 2 (tachistoscope, subject-controlled): Experimenter returned and presented subject with 24 prepared slides of eight common objects, each represented at three levels of complexity. Subject was shown how to use the tachistoscope (exposure time = 1/5 second, and could expose the randomly arranged slides, each as many times as subject desired. The measure in this condition was the number of times each slide was exposed: In condition 1 (Semi-structured observation): Measures were the (a) cumulative time with each stimulus object, (b) *cumulative time with each* class of objects, (c) total time with all objects. The basic assumption here is that the duration of activity directed toward a given object and the number of exposures of the slides reflect the intensity of the underlying drive state; ie., curiosity. Analysis of variance gave a 2 x 2 x 3 table of age, ability and complexity level for condition 2. The F values by ability, age and stimulus complexity were all significant beyond . 01 conference level, but not significant across variables. Mean total exposures: second grade subjects, M = 87. 25; sixth grade subjects, M = 68. 04 ($p. < .05$); second grade, gifted subjects, M = 95. 88; sixth grade, average subjects, M = 62. 88 ($p < .05$). An analysis of variance for condition 1 of the cumulative time per stimulus object by ability, age and object yielded significant F ratios only for the variance across objects ($p < .01$). Applying Duncan's New Multiple-Range Test to the mean time per object for all subjects showed mean of (3) jig saw puzzle significantly greater than any other object ($p < .01$). ANOVA by object categories was not significant by age or ability or their interaction, but the mean time for object category, using Multiple-Range Test, was significant for the other two means ($p < .01$); ie., (3) and (4), M = 238.61; (5) and (6), M = 27.04.

Discussion: The greatest time spent with the jig saw puzzle might be due to its combination of stimulus characteristics, complexity, manipulability and novelty. The results suggest that epistemically-derived exploration is most effective and preceptually-derived exploration least effective in sustaining exploratory behavior. Ability and age did influence exposure frequency in the subject-controlled tachistoscope stimulus, in that the brighter and younger subjects showed more desire to repeat the visual stimulus. They exposed slides more times than was needed to identify the objects, and possibily the greater experience of older children may affect the smaller amount of this type of curiosity behavior. The F ratio for the kaleidoscope showed a pattern similar to the tachistoscope data, which could bear further exploration. The study involved several elements which are suggestive and might be more isolated for further study.

4.7.4 INTERVENTION

4.7.4.1 Cantor, G.N., and Cantor, J.H. Effects of conditioned-stimulus familiarization on instrumental learning in children. Journal on Experimental Child Psychology, 1964, 1, 71 - 78.

The general interest in this study is that of adaptation to a conditioned stimulus, and the hypothesis investigated is if a child is forced to attend to a repeated visual or auditory stimulus, what effect will this familiarization have on his subsequent performance in an instrumental conditioning situation with the original stimulus as the conditioned stimulus. Measures were taken of the response rates to the (C-S) familiar, and the new or novel stimulus. Subjects were 60 kindergarten children in a public school in Iowa; mean CA was 5 yr. 11 months. Stimuli were a light or a buzzer which was presented 40 times for 2 seconds every 5 seconds during a familiarization period. Subjects were primed to expect this stimulus, and were randomly assigned to either the light or the buzzer as C-S. In the conditioning phase, at the signal (light or buzzer), subject was to pull a lever which produced a marble. Marbles could be exchanged for a toy, and speed was indicated as important in the instruction. A verbal "ready" signal preceeded each of the 50 reinforced trials, for which light and buzzer were the signal half of the time, in a random sequence. Measures used were the starting time from signal to initial movement, and total length of time of response.

Results: Generally subjects responded faster to the novel (unconditioned) stimulus, and to the light rather than to the buzzer. A Linguistic Type VII analysis showed the significant main effects to be Novelty-Familiarity (p .005), Sense modality (p .001), and Trial blocks (p .001). The major findings were that the starting speeds in response to a novel stimulus were significantly faster than to a familiar stimulus.

4.7.4.2 Cantor, J.H., and Cantor, G.N. Children's observing behavior as related to the amount and recency of stimulus familiarization. *Journal of Experimental Child Psychology*, 1964, 1, 241-247.

> This study was carried out to verify data from a study in which kindergarten children spent less time with "familiar" than with "novel" stimuli and who showed the same degree of preference following either a 5-minute or 2-day delay. A new element in this study was the amount of prior experience with the familiar stimuli. Subjects were 104 kindergarten children in Iowa City, 13 in each subcategory of the experiment, with a mean age of 73 months. Apparatus for slide projection was used. Three sets of 10 color cartoons were used, two of these sets were counterbalanced for "novel" and "familiar," and the third set was used to equate the total time in the experiment for the subjects in the low familiarity condition. Conditions were: high amount of familiarization--seven presentations of one set of 10 stimuli in seven random orders; low familiarization--the first 60 pictures were of the extra stimuli set and the last 10 in the test set; following one of the above conditions, subject was allowed to expose the "test" or familiar set of 10 pictures for himself. Then, after either a 5-minute or 2-day delay, subject projected for himself 20 pictures, 10 of the familiar set and 10 new pictures (alternate set) and the length of exposure was recorded.
> Results: The five significant effects were familiarity ($p < .001$), trial blocks ($p < .005$), familiarity x amount of familiarization ($p < .0005$), amount of familiarity x counterbalancing condition ($p < .025$), and trial blocks x familiarization x counterbalancing condition ($p < .05$). Subjects in all groups spent less time with the familiar than with the new stimuli. There was a general tendency to look at the later pictures for a shorter time. The effect of familiarization was greater under the high amount of familiarization condition. Differences between the familiar and "novel" means were significant for both the low amount of familiarization condition ($p < .005$) and the high amount condition($p < .001$). There was no significant difference related to the length of the delay. The effect of familiarity was the same after 5 minutes or 2 days. The difference in the length of time spent with the familiar and "novel" pictures was significantly greater for the high than for the low amount of familiarization group.

4.7.4.3 Cantor, J.H., and Cantor, G.N. Observing behavior in children as a function of stimulus novelty. *Child Development*, 1964, 35, 119-128.

> This study attempted to relate stimulus novelty to children's observing behavior. Subjects were 27 girls and 39 boys in kindergartens in two Iowa towns: age range, 66-90 months; mean, 74 months. Variables were (1) relative amount of time spent observing

familiarized versus new or "novel" visual stimuli (assuming that projections time equaled observation time), and (2) time intervals between familiarization and testing; the criterion task was given 5 minutes or 2 days after familiarization. Stimuli were 20 pictures selected from Welsh Figure Preference Test drawings, half of which were used as the familiar set with half the subject's, the remaining 10 pictures being novel for these subjects and counterbalanced for use with the other half of the subjects. During familiarization, subject was seated in front of a screen and told that there would be pictures to look at. The initial set of drawings were projected singly for 6 seconds each, in five random sequences. After these 50 presentations, subject was taught how to project pictures for himself, and subject continued to expose 20 more drawings, while length of exposure for each stimulus was timed to the nearest .1 second. The short delay groups (designated SA, 18 subjects, and SB, 18 subjects, according to the familiarization sets of stimuli A and B) were given a 5-minute rest. Long delay groups, LA and LB (each 15 subjects), returned to class after familiarization and were tested 2 days later in the same manner as the short delay groups. In the test phase, instructions were repeated for projecting the slides, and subjects were told to look at each as long as desirable. Sequences of 10 familiar and 10 new slides, determined by random pairing were used. A reciprocal transformation was used on the scores of observation times (in seconds) for novel familiar pairs, over 10 trials per subject, and ANOVA performed on these were significant but these were mainly a function of group SA's very short observing time. (The mean of SA compared with those of the other groups was shown to be significant at the p .0005 level, and SA apparently differed from the other groups before the delay or introduction of novel stimuli.). Main effect of novelty had a significant F ratio. Observing times for the novel stimuli changed little over trial blocks but were decreasing for familiar stimuli. A new feature of this study was the attempt to measure sustained attention value of each stimulus. Delay length did not seem to influence the relative attention value of familiar or novel stimuli. The authors conclude that their results indicate under these experimental conditions, kindergarten children spend more time observing "novel" as opposed to "familiar" visual stimuli. Their closing comment is on the inadequacy of terminology for defining "novelty."

4.7.4.4 Rieber, M., and Johnson, B.M. The relative effects of alternating delayed reinforcement and alternating reinforcement on response speeds of children. *Journal of Experimental Child Psychology*, 1964, 1, 174-181.

Other studies have shown that delayed reward retards response speed of children performing simple instrumental tasks. The objective in this study was to see if children would learn to anticipate

different reward conditions by responding more rapidly to a stimulus followed by immediate reward, and to observe the effects of different delay times. Apparatus was a panel which lighted up red or yellow, and an attached reward dispenser for toys and trinkets which was operated by a lever. The task was to press the lever every time the light appeared, and the measure used was the response latency. Two experiments were run. Experiment 1: 94 kindergarten subjects were evenly divided into four groups designated according to length of reward delay in seconds, D-O, D-4, D-8, and D-16. One color light was always associated with the delay for each subject and 15 immediately rewarded trials were alternated with 15 delay rewarded trials. In experiment 2, 48 kindergarten subjects were divided into two groups: PR--received 15 reinforced trials alternated with 15 nonreinforced trials; CR--same as D-O above; i. e., immediate reinforcement on all trials. In the PR condition, the color of the lights and reinforcement on the odd-even trials were counterbalanced.
Results: An inspection of the data for experiment 1 showed that response speeds were consistently faster on the delayed reward trials and slower in the immediately rewarded trials. The three delayed reward groups did not differ significantly from each other, but an ANOVA on these versus the immediate reward group, D-0, showed a significant difference ($p < .001$). In experiment 2, the PR response speeds were significantly faster on the reinforced trials than on the nonreinforced ones ($p < .01$), but the PR group did not differ significantly from the CR group in response time on the reinforced trials. The nonreward situation was learned quickly, but different variables seem to operate in situations of delay and of nonreward. The authors mention Anselm's discussion of frustration as an aversive motivational condition, and suggest that perhaps the frustration on the delayed reward in experiment 1 acts so as to slow the response on the succeeding trials where the reward is immediate.

4.7.4.5 Sidowski. J. B., Kass, N., and Wilson, H. Cue and secondary reinforcement effects with children. Journal of Experimental Psychology, 1965, 69, 340-342.

This study investigates the differential between potential cue properties (i. e., the tendency for response to occur following stimulus presentation) and reward or secondary reinforcement (i. e., "Sr"--reinforcement properties indicated by an increase in the strength of a response that precedes the onset of the stimulus) of a light stimulus during the conditioning of a lever-pulling response and measures the effects of each during extinction. Little work has been done to differentiate cue and secondary reinforcement effects, and studies do not always clearly indicate which of the two processes is occurring. If secondary effects exist and/or are unconfounded by cue effects, one would expect greater resistence to extinction by the secondary reinforcement technique when tested in a design which allows for differentiating these two phenomena. Subjects were 140 kindergarten children, 5. 3 to 6. 3 years, with an equal number of boys and girls assigned to each experimental condition. Apparatus included a simulated slot machine which dispensed pennies that were in turn used to buy small toys. Each child was asked which toy he wanted and was told to obtain as many pennies as possible and that he could play as long as he wanted to. There were four training conditions: (1) primary reinforcement, Pr, in which subject obtained one penny for each pull; (2) secondary reinforcement, Sr: a red light was associated with the penny during conditioning such that as soon as the lever was pulled down the light appeared and remained on until the penny appeared in the cup; (3) Cue: the red light appeared at the beginning of each trial before the lever was pulled and turned off before the penny appeared; (4) combined Sr/Cue effects: the red light appeared while the handle was still in the up or off position and remained on until the penny appeared, whereupon it turned off until the next trial. Immediately after the 10 conditioning trials, the subjects in the (2) Sr, (3) Cue, and (4) Sr/Cue conditions underwent one of two extinction procedures; i. e., (a) Light, in which only the light appeared after the response and (b) No Light, in which neither pennies nor light appeared. The Pr group continued to receive pennies. Therefore, there were seven subgroups with 20 subjects (10 boys and 19 girls) in each. The temporal relation of the light to the response remained the same during extinction trials as during the conditioning. Each subject in all groups played until he indicated that he wanted to stop or until he had completed 100 extinction trials. Subject's comments and questions were ignored by experimenter. At the end of the session subject was told that he would receive his toy after everyone in the class had played the game. The raw score of number of responses during extinction was transformed into log values to reduce the heterogeneity of variance, and the mean log number of response and (b) No Light, in which neither pennies nor light appeared. The Pr group continued to receive pennies. Therefore, there were seven subgroups with 20 subjects (10 boys and 10 girls) in each. The temporal relation of the light to the response remained the same during extinction trials as during the conditioning. Each sibject in all groups played until he indicated that he wanted to stop or until he had completed 100 extinction trials. Subject's comments and questions were ignored by the experimenter. At the end of the session subject was told that he would receive his toy after everyone in the class had played the game. The raw score of number of responses during extinction was transformed into log values to reduce the heterogeneity of variance, and the mean log number of responses during extinction is given here:

Extinction Condition	Sr	Cue	Sr/Cue	Pr
Light	1.19	.80	.94	1.61
No Light	.98	.76	.75	

ANOVA on the log values indicated a significant difference between groups, F = 8.15, $p < .01$. The Sr-Light subgroup showed greater resistence to extinction than the Cue-Light, Cue-No Light, or Sr/Cue-No Light conditions in that order, indicating strong support for a reliable Sr effect. Duncan's test for ranked means showed the Pr conditioning penny group displayed significantly more lever-pulling responses than any of the extinction conditions ($p < .01$). The authors conclude that generally the results show (a) the light is a secondary reinforcement when it is directly associated with the presentation of primary reinforcement; (b) if the light is introduced only as the lever is being pulled down (i.e., slightly prior but not during the primary reinforcement interval) the number of responses during extinction are significantly fewer than from the simultaneous presentation of Pr and the light; (c) the combined Sr/Cue situation, which is a common one in many Sr experiments, sustained lever-pulling behavior at a level somewhere between pure Sr and pure Cue conditions.

4.7.4.6 Terrell, Glenn. Manipulatory motivation in children. Journal of Comparative and Physiological Psychology, 1959, 52, 705-709.

This study compares the speed of learning and the consistency of transposition by kindergarten and elementary school children, who were allowed to engage in certain manual manipulations during the solution of a simple task with two other groups. The task was a simple button-pushing response to the larger of two 3-dimensional geometric figures. Subjects were 192 children from one school in Boulder, Colorado, 48 in each age group of 5, 6, 8, and 9 years with an equal number of boys and girls in each group. Within the larger age divisions of 5 to 6-year-olds, and 7 to 8-year-olds, the children were randomly assigned to three different reward situations. Stimuli were three pairs of three-dimensional geometric figures (cubes, cones and cylinders) which were randomized as to order of presentation and position of larger (positive) stimulus for each subject. After a criterion of nine consecutive correct responses on acquisition trials was reached, a four-trial transposition test with the same three differential incentive conditions was carried out. These three differential reward conditions were: (1) the promise of candy after making the light go on enough times (the light lighted following a correct choice of the larger of the stimulus pair); (2) make-believe candy given child after every correct response; child pretended to hold a sack into which he put the candy (manipulative group); (3) only the light indicated a correct response (control). The tests were replicated, with the same age groupings and reward conditions a year apart, so that the total number of subjects in each of the two testings was 96. The results of ANOVA on each of the two criterional measures (number of trials to reach criterion and number of correct responses on the transpositional test): for the acquisition data, the manipulation group II learned the task significantly more quickly than did the other two experimental groups. There was no significant interaction of age-level difference. The author suggests that either manual manipulation or cognitive activity, or both, of the manipulation subjects accounts for their superior performance.

4.7.4.7 Witryol, S. L., and Alonzo, A. A. Social manipulation of preschool children's paired comparisons incentive preferences. Psychology Reports, 1962, 10, 615-618.

This study is based upon earlier experimentation, especially that of the senior author involving the use of a paired comparisons method for determining children's hierarchy of incentive preferences. The new element is the influence of social or external variables upon the incentive value of an object. Even subjects as young as 3 years may respond to extrinsic reward values superimposed on intrinsic reward strengths. The basic hypothesis is the preschool subjects' preferences for specific reward objects are influenced strongly by social suggestion or learning. This study was designed "to demonstrate that a relatively neutral object, judged lowest on a scale by young children, would subsequently be rated higher after verbal social manipulation." Twenty middle class preschool children, mean age 4-3, were presented with five incentive objects (bubble gum, balloons, charms, marbles, paper clips) in condition 1, by the method of paired comparisons. Retest 20 days later, condition 2, involved the additional comment by the experimenter, each time the paper clip was presented, that all the other children like the paper clip most.

Results: In condition 1, distances between 4 successive objects were small (i.e., mean raw scores ranged 2.45-2.05 on a 4-0 scale) while the paper clip clearly anchored the scale with a mean raw score of 1.05. In condition 2, the entire scale was attenuated as the paper clip moved up to second rank, giving it value comparable to the rest of the objects. Kendall's coefficient of agreement (intersubject) was significant in condition 1 only. The specific hypothesis for this experiment was confirmed by one-tailed "t" test value (of the difference between paper clip mean raw scores for condition 1 and 2) beyond the .005 level of confidence. In addition, intrasubject reliability (consistency coefficients) was good (.62 and .60 respectively). The authors conclude that these results demonstrate "the susceptibility of children's incentive objects to social influences," which they label "socially determined valuables."

4.7.7 ANIMALS

4.7.7.1 Denenberg, V.H., and Grota, L.J. Social-seeking and novelty-seeking behavior as a function of differential rearing histories. Journal of Abnormal Social Psychology, 1964, 69, 453-456.

The purpose of this study is to relate preweaning and postweaning experiences to behavior of the subject when placed in a situation permitting access to social and novel stimuli. "Handling" has been shown to influence several different psychological processes and constitutes the preweaning variable here. Postweaning long- and short-term isolation was expected to influence subjects in that socially-reared subjects would be expected to spend more time with the social stimuli than the isolates.

Method: Subjects were 44 Purdue-wistar rats, each from a different litter. Fourteen subjects were kept with the same-sexed littermates until adult testing; 14 isolate subjects had no social experience after weaning; 16 socially reared subjects were placed in individual cages at 90 days (10 days before testing), termed social-isolate. The "handling" condition, which approximately half of each of the above groups had received, involved removing the litter from the mother and placing each subject in an individual can partially filled with shavings for 3 minutes daily for the first 20 days of life. Controls were not disturbed until weaning. The testing apparatus consisted of a plywood T-structure, with division lines painted on the floor, making three "chambers" of approximately 11 inches square each. The empty starting chamber was at the foot of the T, the social chamber was in the left half of the crossbar (with an adult male rat behind a wire mesh as a social stimulus), and the right hand chamber of the crossbar contained three white, wooden 3-D forms, small enough to be manipulated and chewed, (changed daily) as novel stimuli. Subjects at 100 days of age were placed individually in the start chamber or area and their behavior was observed and recorded for 10 minutes on four successive days. Measures taken were the total time spent in each of the three chambers, to the nearest second. Subject was considered to be in the chamber which contained his head and front paws. A gross measure of activity was taken by recording movement from one chamber to another, and a final measure was the number of boluses defecated. The design was a 2 x 3 x 4 factorial with separate ANOVAs computed for time spent in each chamber: (1) successive days, (2) preweaning and handling, and (3) postweaning social, isolation or social-isolate conditions.

Results: Subjects handled spent more time in social chamber than controls ($p < .05$); and the significant days effect ($p < .05$) was a U function, with a drop on the second day and an increase thereafter. Handled subjects spent more time in novel area than controls ($p < .01$)

and time spent with novel stimuli declined on succeeding days at a faster rate for controls than for handled -- significant days effect ($p<.01$); and days x handling interaction ($p<.01$), respectively. Socially reared subjects spent less time in novel chamber than those in either of the other two groups ($p<.05$). A log transformation on the time data reduced the forced negative correlation expected since some of the controls spent most of their time in the start area, so that no statistically significant differences were found on this measure. Handled subjects were more active than controls ($p<.01$); activity of both groups declined over days ($p<.01$), but controls' activity declined more rapidly (days handling, $p<.05$). Controls were more active than handled subjects in the shift from social to isolation; i.e., social-isolate condition, as seen in the handling x rearing interaction ($p<.05$). When activity level was held constant by covariance analyses, handled subjects still spent significantly more time in the novel area than controls did ($p<.01$), but they were not different in time spent in the social chamber. The influence of rearing history upon exploratory behavior and preferences for novel and social stimuli has appeared to be significant, and preweaning handling has a greater effect than postweaning living conditions. The time spent in the social chamber had been expected to discriminate between social and isolated rearing conditions and some ideas for this failure are mentioned. Short-term social isolation eliminated the effects of infantile handling on the activity measure, and a similar pattern, approaching significance, was seen on the social-time variable. The social-isolate groups acted more similarly to those reared in isolation on the novel-time measure and the authors concluded that the results "suggest that there are complex interactions between short-term and long-term social isolation and various dependent variables; for certain criterion measures short-term isolation appears to have functionally different effects than does long-term isolation; on the other measures they have the same consequence."

4.7.7.2 Welker, W. I. Effects of age and experience on play and exploration of young chimpanzees. Journal of Comparative Physiological Psychology, 1956, 49, 223-226.

The purpose of this study is to look at the influence of chimp age upon (1) their initial reaction to small, novel objects, (2) the animal's subsequent behavior after repeated exposure to the objects. The author had already observed and reported upon the faster satiation (of curiosity) for older animals and that infant champanzees 0 to 2 years displayed more caution with small, nonmoving objects than did older animals. Ten stimuli situations were presented to each animal in one or more 5-minute sessions per stimulus situation. The sessions were usually on successive days. Each situation consisted of placing one, two or three objects inside the home cage; experimenter, after placing these objects, sat 3 or 4 feet from the cage taking a sequential record in successive 5-second periods. The behavior recorded was whether the animal looked at (0-score) or touched (M-score) the objects. Each animal was tested on each situation until a criterion level of familiarity was reached, as defined by touching the object 50 out of the possible 60 5-second periods in the session. Postcriterion tests were also made on some of the animals to see if the criterion level remained stable. Statistical significance was determined by two-tailed significiance tests.

Data analysis: A pair of scores was obtained for each session [0 (orientation towards object) and M (manipulation)], and 10 pairs of scores per animal were obtained for the initial session with each situation or set of objects. A+ score was given if M score was greater than 0 score for each pair, and A- score, if M was less than 0. In the initial sessions, the four younger animals oriented towards the new items more than manipulating them (.01 level, 40 subjects), and the four older animals "manipulated" the objects more often than "orienting" to them (.01 level, 39 subjects). More data is given in the table below including the subjects' description:

Animal	Age in Months	# sessions presented	Situations contacted to criterion	# sessions to criterion
Alec	10	88	2	9, 16
Carver	11	89	1	15
Sally	13	89	1	30
Laru	26	85	6	5, 5, 4, 3, 12, 1
Margo	35	86	5	3, 1, 2, 17, 1
Sadie	43	28	10	1, 1, 1, 1, 1, 1, 1, 1, 1, 1
Chow	50	10	10	1, 1, 1, 1, 1, 1, 1, 1, 1, 1
Kathy	57	18	5	1, 1, 1, 1, 1

The five youngest animals required four or more exposures to reach the criterion of familiarity in nine instances. An analysis of these instances to determine the effect of familiarity on behavior towards the objects (i.e., the direction of increase or decrease on manipulatory and orientation behavior recorded between the initial session and the session in which criterion was reached) using the sign test, showed both an increase in manipulatory and decrease in orientation behavior significant at the .01 level. Sixty-two post-criterion sessions with six animals showed that the criterion was stable, once achieved, but the with the introduction of new objects the younger animals were still initially wary. This initial caution of the infants is suggested as similar to the irrational fear or stanger anxiety which they also display, and their caution is overcome with repeated exposure to the stimulus. The author concludes that the age factor is important probably only insofar as the older animals, 3 to 4 years, presumably have had a greater variety of experience with objects and therefore have a greater generalized level of adaptation. There may also be an optimum period at which these animals exhibit play behavior.

4.7.8 GENERAL

4.7.8.1 May, R. B. Stimulus selection in preschool children under conditions of free choice. Perceptual and Motor Skills, 1963, 16, 203-206.

> The purpose of this study was to gather data for the hypothesis that complexity influences the free choice selection of stimuli, from an idea of Dember and Earl's (1957) of "stimulus complexity optimization," which assumes that every stimulus has a complexity value for the individual who perceives it. Stimulus complexity is defined as the degree of change in stimulation or the magnitude or number of changes in the measure of a stimulus on one or more of its attributes. Earlier studies have indicated that sequential responses of subjects are a function of differential stimulus complexity. In this study, complexity is operationally defined by the number of different colored rectangles on a stimulus card and the number, shape and color of parts of constructed objects. Subjects were 21 nursery school children, mean age 4-3. For Part I stimuli were 5 x 8 inch cards with 2, 3, 5, 8, or 12 rectangles in varying patterns; for Part II, five tinker toy "meaningless" objects of graduated complexity. An adaptation technique, described by Musselman, was used for both parts, involving exposure to the stimulus of medium complexity value prior to the test trials; when subject was given a choice among adaptation stimuli, it was predicted that he would choose something more complex than what he had been exposed to. In Part I, after subject had seen all the cards with five rectangles, all five decks were placed before him and he could look at any cards in any deck, but only one at a time. Twenty subjects selected cards other than those of medium complexity as their first choice; 16 of these selected more complex patterns ($p < .006$, 1-tail sign test); and 18 of the 20 selected more of their total choice of cards from the more complex decks. In Part II, experimenter constructed all five objects for subject, then presenting the one of medium complexity, asked if subject would like to make it. If and when subject finished, he was given all five objects and could construct any of them. Twelve of the 21 subjects could make the adaption stimulus. Of these, 11 selected stimulus objects which were more complex ($p < .003$) and the twelfth subject started with the least complex and constructed all objects through the most complex. The initial hypothesis was supported and the similarity of this finding to the notion of hierarchically-organized perceptual responses in man (Krech and Calvin, 1953) was pointed out.

4.7.8.2 Odom, R.D. Children's performance as a function of the degree of visual stimulus deprivation and satiation. Journal of Experimental Psychology, 1965, 69, 618-623.

> Subjects were 112 boys and girls, 8 to 9 years old, who performed a three-stage, lever-pressing task with visual stimuli as reinforcers. In the preexperimental period, there was a response period without, and then with, reinforcers; in the experimental period, there were no lever-pressing responses, but four conditions (2 or 10 minutes, of deprivation, without reinforcement, or satiation, with reinforcement) were presented and denoted as D10, D2, S10, and S2. In the post-experimental period, responses without any reinforcement were obtained. Results showed that the rate of lever-pressing increased as the degree of satiation decreased and the degree of deprivation increased. Results support the notion that visual stimuli can act as a source of motivation.